

## 3D Surface Profiler VK-X3000 Series

Multifile Analyzer Software

CAD Comparison Module  
VK-H3CA

## Reference Manual

Read this manual before use.  
Keep this manual in a safe place for future reference.



1	Getting Started
2	Basic Operations of Multifile Analyzer Software
3	File Management and Creating Reports
4	Image Display
5	Measurement Preprocessing
6	Profile Measurement
7	Plane Measurement (Point Height)
8	Average step (flatness)
9	Volume & Area Measurement
10	Line Roughness Measurement
11	Multi-line Roughness Measurement
12	Surface Roughness Measurement
13	Film Thickness Measurement
14	Parameter Recommendation
15	Comparative Measurement
16	Batch Analysis
Appendix	• Installing • Index

# Introduction

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This manual describes the handling, operating procedures, and precautions for the "VK-X3000 Series Multifile Analyzer Software" and "VK-X3000 Series CAD Comparison Module (VK-H3CA)". Read this manual thoroughly before using the system to ensure optimal performance out of the Multifile Analyzer Software.


Keep this manual on hand for reference as needed.


## Symbols


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This manual uses the following symbols to show important information at a glance.

Make sure to read this section.

	<b>Indicates a hazardous situation which, if not avoided, will result in death or serious injury.</b>
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	<b>Indicates a hazardous situation which, if not avoided, could result in death or serious injury.</b>
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	<b>Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.</b>
--	---

	<b>Indicates a situation which, if not avoided, could result in product damage as well as property damage.</b>
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 Important	<b>Indicates cautions and limitations that must be followed during operation.</b>
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 Point	<b>Indicates additional information on proper operation.</b>
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 Reference	Indicates tips for better understanding or useful information.
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	Indicates reference pages in this manual or other manual.
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# Software License Agreement

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# Organization of This Manual

Chapter 1	Getting Started	This chapter describes the package contents, overview, and operating environment of Multifile Analyzer Software.
Chapter 2	Basic Operations of Multifile Analyzer Software	This chapter describes how to start and exit Multifile Analyzer Software as well as a basic operation flow, and introduces windows and toolbars used in this Software.
Chapter 3	File Management and Creating Reports	This chapter describes basic file operations, and how to output and print data.
Chapter 4	Image Display	This chapter describes various functions of [Image list] on the [Tools] menu, and 3D image.
Chapter 5	Measurement Preprocessing	This chapter describes various functions on the [Process image] menu.
Chapter 6	Profile Measurement	This chapter describes the profile measurement function found on the [Measurement] menu.
Chapter 7	Plane Measurement (Point Height)	This chapter describes the plane measurement (point height) function found on the [Measurement] menu.
Chapter 8	Average Step (Flatness)	This chapter describes the average step height function found on the [Measurement] menu.
Chapter 9	Volume & Area Measurement	This chapter describes the volume & area measurement function found on the [Measurement] menu.
Chapter 10	Line Roughness Measurement	This chapter describes the line roughness measurement function found on the [Measurement] menu.
Chapter 11	Multi-line Roughness Measurement	This chapter describes the multi-line roughness measurement function found on the [Measurement] menu.
Chapter 12	Surface Roughness Measurement	This chapter describes the surface roughness measurement function found on the [Measurement] menu.
Chapter 13	Film Thickness Measurement	This chapter describes the film thickness measurement function found on the [Measurement] menu.
Chapter 14	Parameter Recommendation	This chapter describes each function of [Parameter recommendation] in the [Tools] menu.
Chapter 15	Comparative Measurement	This chapter describes the comparative measurement and 3D-CAD comparative measurement function found on the [Measurement] menu.
Chapter 16	Batch Analysis	This chapter describes various functions in the [Batch Analysis] menu.
Appendix	Appendix	This appendix describes the other functions on the main menu, and how to reinstall and uninstall Multifile Analyzer Software.

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Chapter

# 1

## Getting Started

This chapter describes the package contents, overview, and operating environment of Multifile Analyzer Software.

1

Getting Started

Checking the Package Contents ..... Page 1-2

Overview of Multifile Analyzer Software ..... Page 1-4

# Checking the Package Contents

The VK-X3000 Series Software includes the following items.

Please check the contents before getting started. In the event of defective or broken items, please contact the nearest KEYENCE office.

1

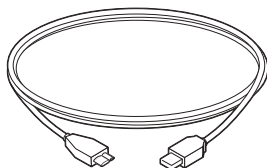
Getting Started

## Observation/Analysis Software (VK-A3E)

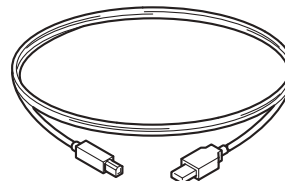
- VK-X3000 Series Software  
Software Installer DVD  
Viewer Software  
Multifile Analyzer Software  
(DVD-ROM)



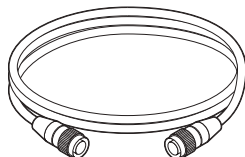
- USB3.0 cable  
(A connector - Micro B connector)  
2 m: 1



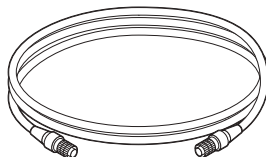
- USB2.0 cable 2m: 1



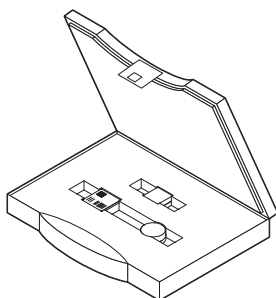
- Cable B 2m: 1



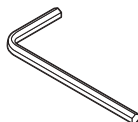
- Cable A 2m: 1



- Maintenance Kit



- L-shaped hexagonal wrench  
(For fixing the measurement unit)



- Hexagon socket bolts  
M6 length 20 mm:6  
M6 length 35 mm:2



- User's Manual



- Quick Start Guide (12 types)



## Image Stitching Module VK-H3J (Optional)

- Image Stitching Module VK-H3J License Sheet..... 1



- Image Stitching Module VK-H3J License Registration Procedure ..... 1



- Image Stitching Module Installer DVD ..... 1

## White Light Interferometry Module VK-H3I (Optional)

- White Light Interferometry Module VK-H3I License Sheet..... 1



- White Light Interferometry Module VK-H3I License Registration Procedure ..... 1

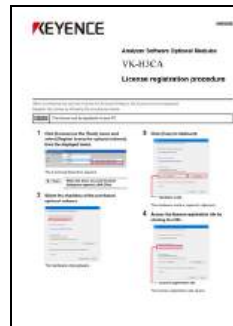


## CAD Comparison Module VK-H3CA (Optional)

- CAD Comparison Module VK-H3CA License Sheet..... 1



- CAD Comparison Module VK-H3CA License Registration Procedure ..... 1



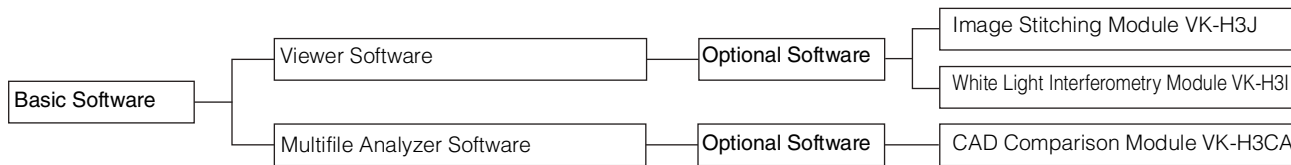
# Overview of Multifile Analyzer Software

## Components of the software

1

Getting Started

The VK-X3000 series software has the following components.



Component	Name	Model	Notes
Basic Software	Viewer Software		Basic software for controlling the profile measuring microscope to observe and perform measurements.
	Multifile Analyzer Software		Basic software incorporating image processing and analysis functions.
Optional Software	Image Stitching Module	VK-H3J	This software adds stitching and teaching functions for captured data. Once installed, stitching measurements and teaching will become available.
	White Light Interferometry Module	VK-H3I	This software adds white light interference measurement capabilities to Viewer Software. Spectral interference measurements will be available when used in combination with an interference objective lens. Wide-area measurements can also be performed using the image stitching application.
	CAD Comparison Module	VK-H3CA	Software that compares measurement data and 3D-CAD data.

The following describes the operating environment of Analyzer Software.  
Specifications may be changed or updated without notice.

## Control PC main specifications

### Operating environment

OS	Windows 10/11 Pro 64-bit version must be pre-installed.
CPU	Intel® Core™ i5-11600 or later
Memory	16 GB or more
USB port	USB 2.0 x 2, USB 3.0 x 1
Video card	NVIDIA® T400 2GB
Display resolution	1920 x 1080 pixels

#### Important

- **Operation is not guaranteed on all computers that meet the above requirements.**
- **Do not install on computers other KEYENCE-specified computers or equivalent (with pre-installed Windows 10/11 Pro). Installing the software on a computer running an operating system other than Windows 10/11 may cause the computer system files and installed applications to stop working correctly.**
- **Set all of the power settings to “None” on the Power Options Properties dialog box for the control PC.**

## MEMO

Chapter

# 2

## Basic Operations of Multifile Analyzer Software

This chapter describes how to start and exit Multifile Analyzer Software as well as a basic operation flow, and introduces windows and toolbars used in this Software.

Startup and Shutdown .....	Page 2-2
Basic Operation Flow .....	Page 2-3
Understanding Each Window .....	Page 2-4
Selecting the Main Image .....	Page 2-17

2

Basic Operations of Multifile Analyzer Software

# Startup and Shutdown

The following describes how to start up and shut down Multifile Analyzer Software.

## Starting Up

The Multifile Analyzer Software starts from the VK-X3000 Multifile Analyzer Software.

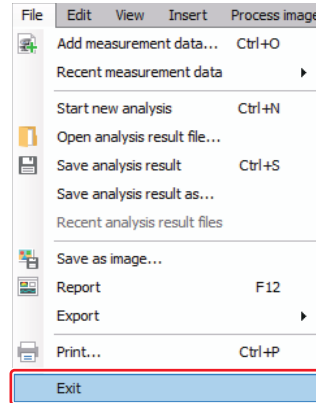
- 1 Either double-click the [VK-X 3000 MultifileAnalyzer] icon on the desktop, or click the [Start] button → [KEYENCE VK-X3000 Series] → [VK-X 3000 MultifileAnalyzer] on the Windows task bar.

The VK-X3000 Multifile Analyzer Software starts.

## Exiting

Exit the Multifile Analyzer Software.

- 1 Select [Exit] from the [File] menu. Or, click the [x] button at the upper right of the screen.

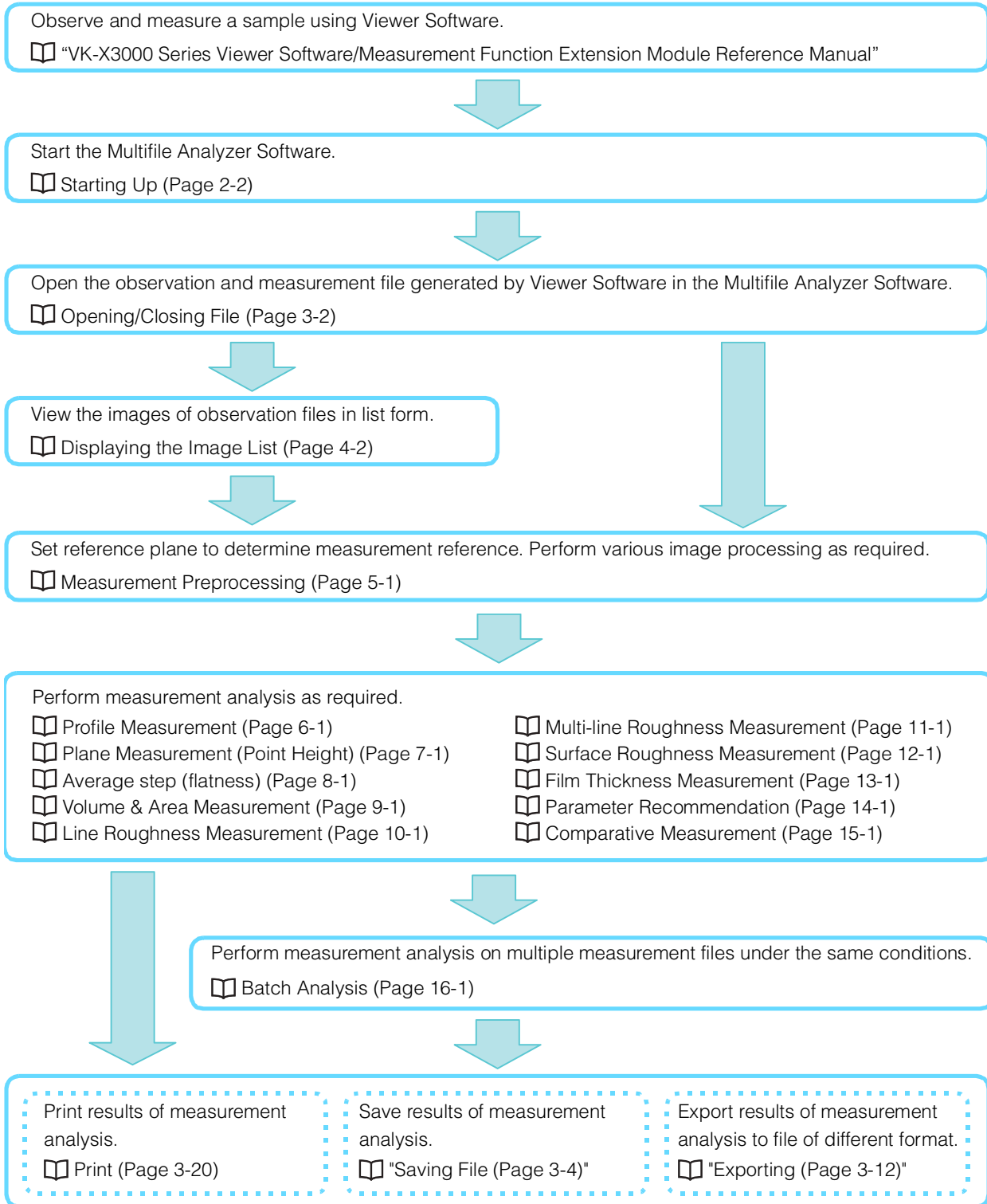


The VK-X3000 Multifile Analyzer Software shuts down.

# Basic Operation Flow

The following shows the flow of basic operations in Multifile Analyzer Software.  
For details on the operations, refer to the referenced pages.

## ■ Analysis flow



# Understanding Each Window

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When you open the measurement data in Multifile Analyzer Software, a grid sheet appears in the Main Window. The results of measurement and analysis are added as new sheets and can be switched by tab. On the grid sheet, you can manage the result of measurements and operation using spreadsheet-like operations.

The types of window used in Multifile Analyzer Software are as follows.

## 2


### Main Window

This is the window that appears when Multifile Analyzer Software starts up. This area displays the grid sheet.

 Main Window (Page 2-5)

### Image List Display Window

This window displays the images of multiple measurement data in list form.

 Image Display (Page 4-1)

### Image Processing Window

These are used to perform various types of image processing.

 Measurement Preprocessing (Page 5-1)

### Measurement Editing Windows

This is the general term for windows used to measure measurement data. Configure the settings for different measurement types.

 Measurement Editing Windows (Page 2-16)



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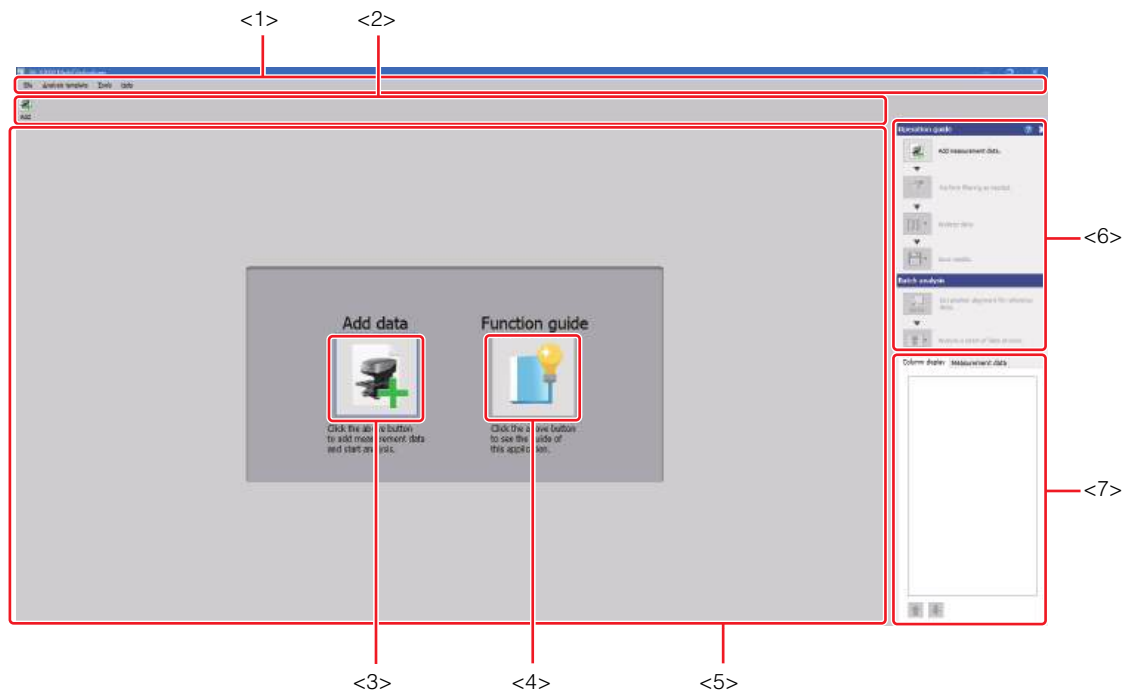
Some items displayed on the screen may differ depending on the measurement mode (shape measurement or film thickness measurement mode).

---

The following describes the name and functions of each window.

## Main Window

When Multifile Analyzer Software starts, the main window is displayed. When measurement data is added, a grid sheet appears in the main window.



The following describes the name and function of parts of the main window.

### <1> Menu bar

This area contains menus for executing various commands. Unavailable menus are grayed out.

### <2> Toolbar

This area contains buttons for frequently used functions. Click a button to load the corresponding function.

📖 Toolbar (Page 2-6)

### <3> [Add data] button

Click to open measurement data of VK-X3000 Series Viewer.

📖 Opening/Closing File (Page 3-2)

### <4> [Function guide] button

Click to display operation guidance for Multifile Analyzer Software.

📖 Using the feature guide (Page A-67)

### <5> Grid display area

This area displays the grid sheet.

📖 Grid view area (Page 2-8)

### <6> Operation guide

This area displays the tool buttons for the main functions in the flow of basic operation of Multifile Analyzer Software.

### <7> Image list area

This area displays settings of the view column and measurement data.

📖 List display area (Page 2-12)

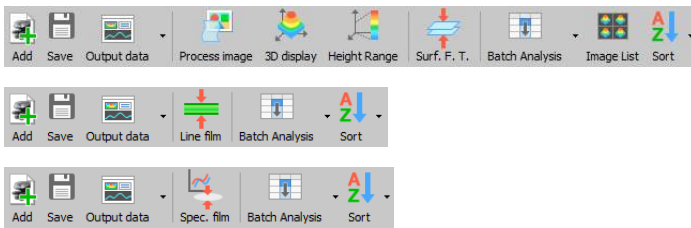
## Toolbar

The tool bar in the main window provides frequently used functions as buttons. Click the buttons to execute the corresponding function.

### ●Shape/Roughness



### ●Film thick



**Point**

The tool buttons are not available if other windows are open.

The following describes the functions of the buttons.



#### [Add] button

Opens measurement data (\*.vk7, \*.vk6, \*.vk4, \*.vk3).

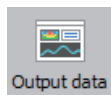
Opening/Closing File (Page 3-2)



#### [Save] button

Saves the report file of the measurement and analysis results (\*.zag).

Opening/Closing File (Page 3-2)



#### [Output data] button

Saves the measurement data in report format, Excel format, or as an image.

Report (Page 3-9)

Exporting as Excel File (Page 3-15)

Saving as an image (Page 3-5)



#### [Process image] button

Opens image processing window.

Chapter 5, Measurement Preprocessing (Page 5-1)



#### [3D display] button

Displays a 3D image of the selected data.

Checking/Configuring a 3D Image (Page 4-3)



#### [Height Range] button

Click to set display of height image.

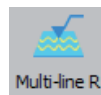
Settings for Displaying a Height Image (Page 4-9)



#### [Line R] button

Conducts line roughness measurement.

Chapter 10, Line Roughness Measurement (Page 10-1)



#### [Multi-line R] button

Performs multi-line roughness measurement.

Chapter 11, Multi-line Roughness Measurement (Page 11-1)



#### [Surf R] button

Performs surface roughness measurement.

Chapter 12, Surface Roughness Measurement (Page 12-1)

**[Profile] button**

Performs profile measurement.

📖 Chapter 6, Profile Measurement (Page 6-1)

**[Compare] button**

Compares measurements.

📖 Chapter 15, Comparative Measurement (Page 15-1)

**[Compare CAD] button**

Conducts 3D-CAD comparative measurement.

📖 Chapter 15, Comparative Measurement (Page 15-1)

**[Ave step] button**

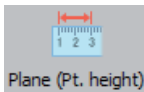
Measures average step height (flatness).

📖 Chapter 8, Average step (flatness) (Page 8-1)

**[Vol & area] button**

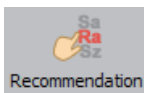
Measures volume and area.

📖 Chapter 9, Volume & Area Measurement (Page 9-1)

**[Plane (Pt. height)] button**

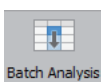
Conducts 2D plane measurements.

📖 Chapter 7, Plane Measurement (Point Height) (Page 7-1)

**[Recommendation] button**

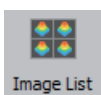
Compares the line roughness or surface roughness parameters of 2 sets of measurement data.

📖 Chapter 14, Parameter Recommendation (Page 14-1)

**[Batch Analysis] button**

Applies analysis settings of one set of measurement data to another set of measurement data.

📖 Chapter 16, Batch Analysis (Page 16-1)

**[Image List] button**

Displays main images or the 3D images of measurement data in list form.

📖 Displaying the Image List (Page 4-2)

**[Sort] button**

Changes the order of the selected lines.

📖 Sorting (Page 2-12)

**[Line film] button**

Conducts line film thickness measurements.

📖 Chapter 13, Flow of Laser Film Thickness Measurement (Line Film Thickness Measurement) (Page 13-2)

**[Surf. F. T.] button**

Conducts surface film thickness measurements.

📖 Chapter 13, Flow of Laser Film Thickness Measurement (Surface Film Thickness Measurement) (Page 13-13)

**[Spec. film] button**

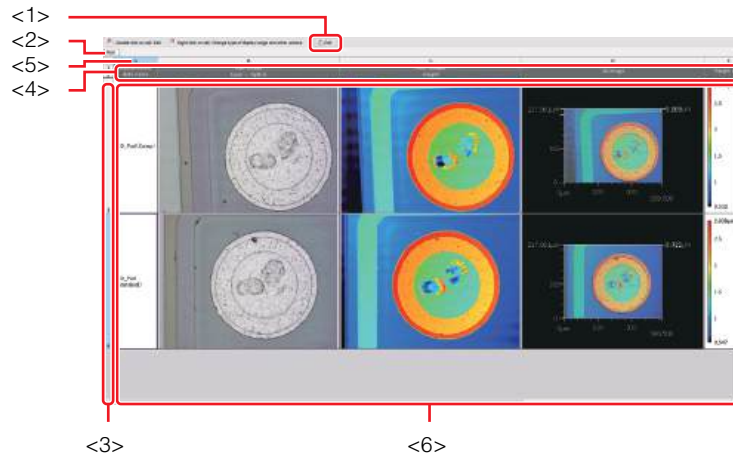
Conducts spectral film thickness measurements.

📖 Chapter 13, Flow of Spectral Film Thickness Measurement (Page 13-24)

## Grid view area

Displays image of measurement data or results of measurement analysis in table format sheet. This sheet is called a grid sheet.

When you add measurement data, the data is displayed in rows, starting from the top. When you perform measurement analysis, a grid sheet is added.



### <1> Edit analysis setting

Click the [Edit] button to display the measurement editing window for the currently selected grid sheet.



- You can delete a grid sheet by right clicking on the measurement tab. The [Main] tab cannot be deleted.
- The measurement name on the tab cannot be changed.

### <2> Tab

Displays the grid sheet name. When you perform measurement analysis, a new grid sheet is added and measurement name is displayed in the tab. Click on the tabs to change between grid sheets.



If you try to start measurement analysis on the same measurements while the measurement result grid sheet is displayed, the [Edit or add] dialog box will appear.



Click the [Edit in sheet] button to display the measurement editing window for the currently selected grid sheet. Click the [Add new sheet] button to add a new grid sheet and start measurement analysis.

### <3> Column number

Click the column number to select the entire column. The following operations are provided in the column number right-click menu.

#### [Hide]

Hides the selected column.

List display area (Page 2-12)

#### [Delete measurement data]

Removes the selected measurement data from the grid sheet.

#### [Copy]

Copies text data in the selected column.

#### [Unify position alignment/image processing/measurement details]

This sets the image processing and measurement details for multiple measurement data at a time.

#### [Move to new Analyzer]

Start a new Multifile Analyzer Software, and open the selected measurement data.



- The analysis result and image processing will not be transferred.

**<4> Heading line**

Displays item names, such as a measurement data name or measurement result etc.


**<5> Line number**

Click the line number to select the entire line.

The following operations are provided in the line number right-click menu:

**[Hide]**

Hides the selected line.

 List display area (Page 2-12)

**[Copy]**

Copies text data in selected line.

**<6> Measurement data row**

Displays 1 set of measurement data in each row. The number of rows increases as measurement data is added. The boxes separated by the dividing lines are called cells. Click on a cell to select the measurement data in that cell. Depending on the content in the cell, right-clicking may bring up a right-click menu, and double-clicking may open different types of settings windows.




- Drag the edge of a line number or column number to alter the height of the rows or the width of the columns. If the entire text or graph is not displayed, please adjust the size of cells.
- You can click a cell or a line number/column number while pressing Ctrl/Shift key to select multiple items.

The following operations are provided from the right-click menu of the measurement data line.


**Rename**

Change measurement data name.

 You can also open the [Rename] dialog box by double-clicking the name cell.

**Image size**


Select a size for the displayed image from [Large], [Medium] and [Small].

 Only displayed when the main image or 3D image is right clicked.

**Process image**


Opens image processing window.

 Chapter 5, Measurement Preprocessing (Page 5-1)

 Only displayed when the main image is right clicked.


**Laser+Optical**

Sets the main image to laser + color image.

-  Only displayed when the main image is right clicked.
- If the main image is set to laser + color image, [Laser+Optical] will be checked.


**Optical**

Sets the main image to color image.

-  Only displayed when the main image is right clicked.
- If the main image is set to color image, [Optical] will be checked.


**Laser**

Sets the main image to laser image.

-  Only displayed when the main image is right clicked.
- If the main image is set to laser image, [Laser] will be checked.


**Laser intensity**

Sets the main image to laser intensity image.

-  Only displayed when the main image is right clicked.
- If the main image is set to laser intensity image, [Intensity] will be checked.


**Height**

Sets the main image to height image.

-  Only displayed when the main image is right clicked.
- If the main image is set to height image, [Height] will be checked.


**C-DIC**

Sets the main image to C-DIC image.

-  Only displayed when the main image is right clicked.
- If the main image is set to C-DIC image, [C-DIC] will be checked.


**Scale**

Displays the scale in the main image display area.

 Only displayed when the main image is right clicked.

**Image view**

Opens the [Image view] dialog box.


 Checking/Configuring the Main Image (Page 4-2)



Only displayed when the main image is right clicked.

**HDR view set**

Opens the [HDR view set] dialog box.


 Checking/Configuring the Main Image (Page 4-2)



Only displayed when the main image is right clicked.

**Set Height Display**

Opens the [Set height display] dialog box.

 Checking/Configuring the Main Image (Page 4-2)



Only displayed when the main image is right clicked.

**Show meas.cond**

Displays the [Show meas.cond] dialog box.



Only displayed when the main image is right clicked.

**Output CSV file**

Exports the contents of main image in CSV format.



Only displayed when the main image is right clicked.

**Show list/Save CSV**

Exports the display contents in CSV format.



Only displayed when the measurement result (table) is right clicked.

**Show data/Save CSV**

Exports the display contents in CSV format.



Only displayed when the measurement result (graph) is right clicked.

**Row display setting**

Sets the display items for the row of measurement result.



Only displayed when the measurement result (table) is right clicked.

**Column display setting**

Sets the display items for the column of measurement result.



Only displayed when the measurement result (table) is right clicked.

**3D display setting**

Displays the [3D display] dialog box.

 Configuring Image Display (Page 4-4)



Only displayed when the 3D image is right clicked.

**Apply previous 3D display settings**

Changes the 3D image to the settings configured in the [3D display] dialog box.




Only displayed when the 3D image is right clicked.

**Edit analysis setting**

Displays the measurement editing window for the currently selected grid sheet.

**Report**

Displays the measurement result in another window in report form.

 Report (Page 3-9)

**Copy**

Copies the currently selected cell.

**Font settings**

Sets the font.



Only displayed when the character information is right clicked.

**Batch height range settings**

Displays the [Batch height range settings] dialog box.


 Using Batch Height Range Settings (Page 16-2)



Only displayed when the main image or measurement result (graph) is right clicked.

**Unify position alignment/image processing/measurement details**

Displays the [Unify position alignment/image processing/measurement details] dialog box.

 Unifying position alignment/image processing/measurement details (Page 16-4)

**Output DXF file**

Exports the display contents in DXF format.



Only displayed when the measurement result (graph) is right clicked.

**Move to new Analyzer**

Start a new Multifile Analyzer Software, and open the selected measurement data.

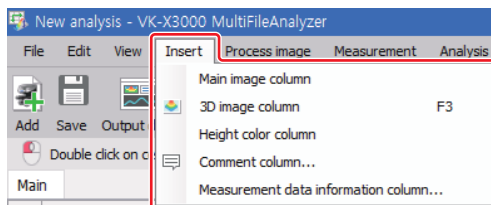


The analysis result and image processing will not be transferred.

## Inserting items

Adds an item column to the grid view area.

- 1 From the [Insert] menu, select the item column you wish to insert.



### [Main image column], [3D image column]

This item displays the image of the measurement data.

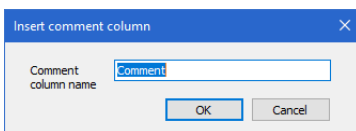
### [Height color column]

This item displays the color palette corresponding to the measurement data height image.

### [Comment column]

You can input characters in this item.

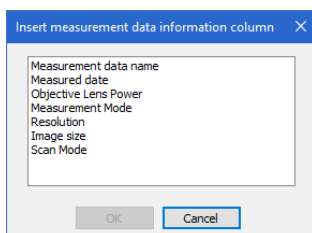
When selected, the [Insert comment column] dialog box appears. Enter the name of the comment column and click the [OK] button.



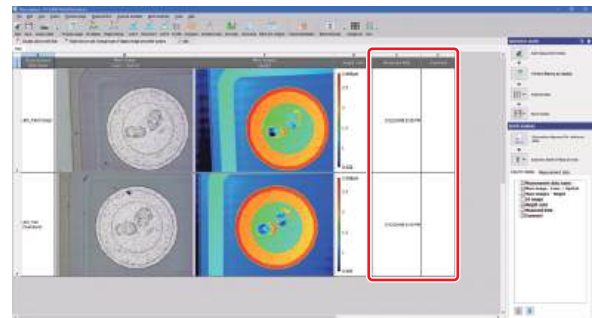
### [Measurement data information column]

This item displays measurement data information.

Type of measurement data	Description
Measurement data name	Measurement data file name
Measured date	Measured date and time
Objective Lens Power	Example: 10
Measurement mode	The mode used for measurement
Image size	Meas. result size
Scan mode	Sample scan mode



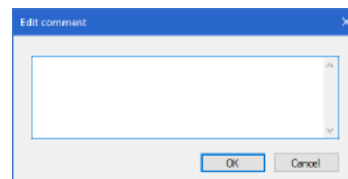
The selected item column is added after the last item.



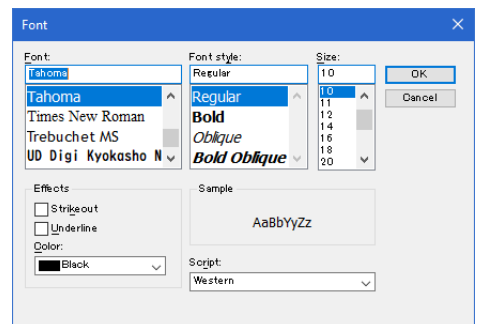
If the same item is already present, a number is automatically added to the item name.

### Point

- When you double-click on a cell in the comment column, the [Edit comment] dialog box appears. With this item, you can enter a comment of up to 1024 half-width characters. After entering your comment, click the [OK] button.



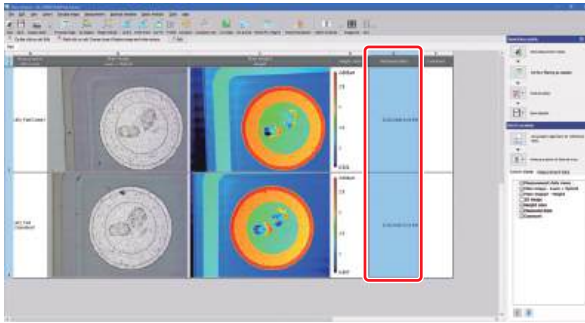
- Select [Font settings] from the right-click menu in the comment column to set the font type, style, size etc. When selected, the [Font] dialog box appears. After entering your comment, click the [OK] button.



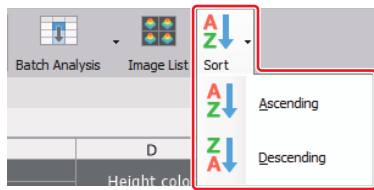
## Sorting

Compare text or measurement results and sort the measurement data in ascending or descending order.

### 1 Select a column or a cell to sort.



### 2 From [Sort] on the toolbar, select [Ascending] or [Descending].



The order of the measurement data is rearranged.

**Reference** You can also sort by doing the following.

- In the right-click menu of the column number, select [Sort] and then [Ascending] or [Descending].

**Point** • If you select an image or multiple columns, sort will not be available.

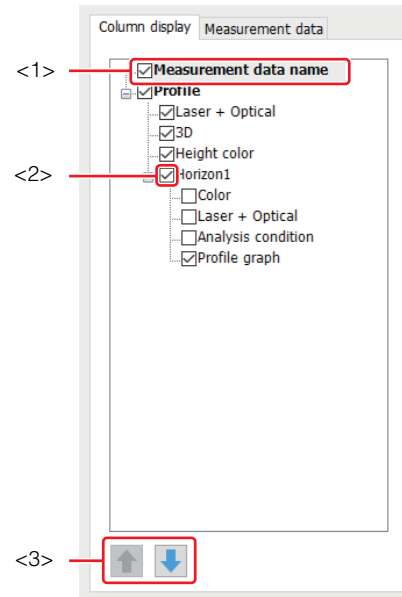
- Empty cells are arranged after the cells containing values, irrespective of whether the cells are arranged in ascending order or descending order.

## List display area

Set the display and order of the row items and measurement data displayed in the grid view area in the list display area. Set the row item in the [Column display] tab, and set the measurement data in the [Measurement data] tab.

### [Column display] tab

This displays the file name and the analysis settings.



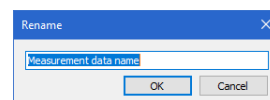
### <1> [Measurement data name]

This displays the items in the heading row of the grid view area. The measurement data names displayed in bold text are displayed uppermost in the heading row. Use the checkboxes to select which items to display/hide. Related items are displayed in a tree structure. If you deselect an item in the upper level of the tree structure, all items under the hidden item will also be hidden. This operation does not change the checkbox settings for the lower items.

**Reference** You can rename column headers by utilizing the right click menu and selecting the [Rename] button. Columns can also be deleted using the right click menu.

[Rename]

With the analysis setting name selected, click the button to display the [Rename] dialog box. To rename the analysis setting, enter a name and click the [OK] button. Renaming is only available for the analysis setting names displayed in bold text.



**[Delete]**

With the measurement data name selected, click the button to delete the analysis setting. If you delete a column in bold text, all settings within that tree display will also be deleted.

**<2> Collapse button**

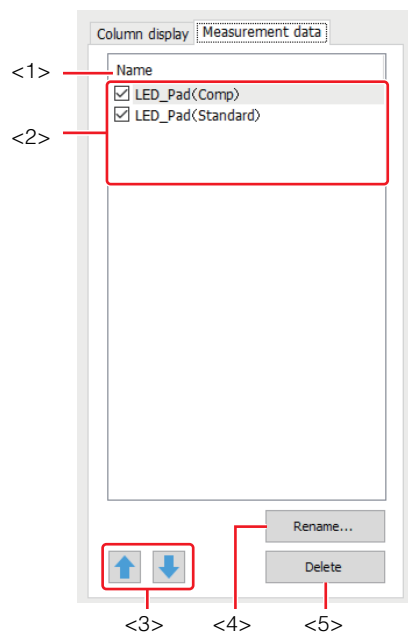
This button is displayed if there are items associated with an analysis setting. Click it to collapse all items within the tree. Click again to expand the tree as before.

**<3> [Move up/Move down] button**

With the analysis setting name selected, click the button to switch the item order.

**[Measurement data] tab**

This content is common to all grid sheets. The settings of the [Measurement data] tab are applied to all grid sheets.

**<1> [Name] title**

Clicking on Title, sorts the measurement data by name.

**<2> [Measurement data]**

Click the checkbox to display or hide the measurement data.

**Point**

You can still perform measurement processing with the measurement data hidden.

Depending on the type of export, this hidden data may or may not appear:

Type of export	Export result
Output CSV file	Export performed, hidden data will appear.
Exporting to Excel file	Export performed, hidden data will not appear.
Printing or saving as	Export performed, hidden

**Reference**

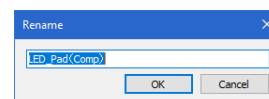
- Click while pressing Ctrl or Shift to select multiple measurement data rows.
- You can also rename and delete measurement data, and set display/hidden from the right-click menu of the measurement data row.

**<3> [Move up/Move down] button**

With a measurement data row selected, click these buttons to change the order of the measurement data.

**<4> [Rename] button**

With a measurement data row selected, click this button to display the [Rename] dialog box. To rename the measurement data, enter a name and click the [OK] button.

**<5> [Delete] button**

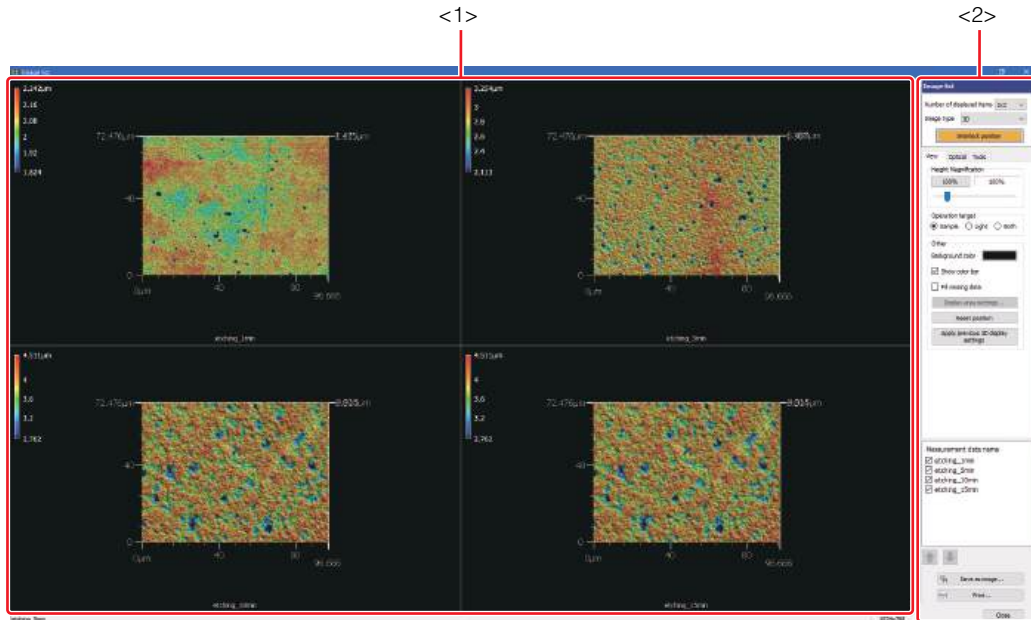
With a measurement data row selected, click this button to delete the measurement data from the Multifile Analyzer Software.

## Image List Display Window

Click the [Image List] button to display the image list display window.

This window displays the images of multiple measurement data in list form.

2



### <1> Image display area

This area displays images of the measurement data in accordance with the number of displayed items and the image type set in the view settings.

Image Display (Page 4-1)

### <2> View settings area

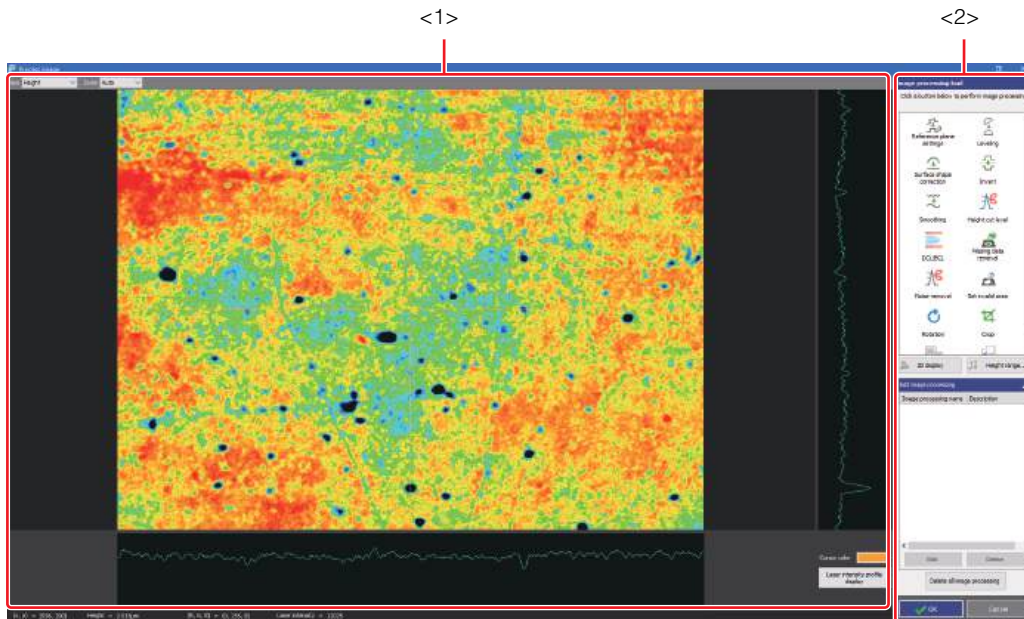
Use this area to configure the view settings for images.

Configuring Image Display (Page 4-4)

## Image Processing Window

When an image is selected, click the [Process image] button in the main toolbar to display the image processing window. This allows you to prepare the image of the measurement data before measurement analysis.

📖 Window Used For Image Processing (Page 5-2)



### <1> Image display area

This area displays the image and profile graphs of the measurement data.

### <2> Image processing settings area

This area is used to configure image processing and the image processing history.

## Measurement Editing Windows

When you start conducting measurements of an image, the measurement editing window appears. Within the measurement editing window, you can use various measurement functions to measure on the image.



The measurement editing window consists of a number of areas which display Measurement Result List, images, profiles, measurement settings, tools used for measurement, and so on.

The composition and content of this window differ according to measurement function.


For more information, see the chapters describing measurement functions.

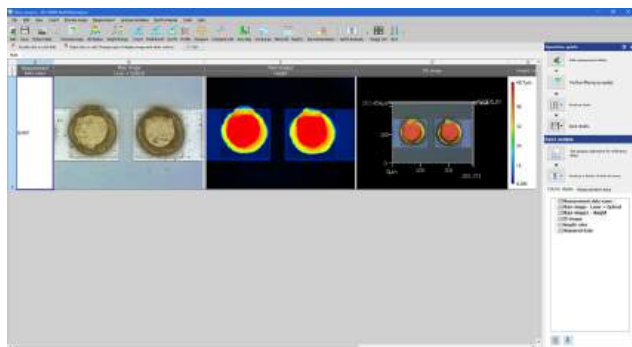
Measurement function	Reference
Profile Measurement	Screen Used for Profile Measurement (Page 6-3)
Plane Measurement (Point Height)	Screen Used for Plane Measurement (Point Height) (Page 7-3)
Average Step (Flatness)	Measurement results list (Page 8-4)
Volume & Area Measurement	Screen Used for Volume & Area Measurement (Page 9-3)
Line Roughness Measurement	Line Roughness Measurements Window (Page 10-3)
Multi-line Roughness Measurement	Screen Used for Multi-line Roughness Measurements (Page 11-3)
Surface Roughness Measurement	Screen Used for Surface Roughness Measurement (Page 12-3)
Line film thick.meas	Screen Used for Line Film Thickness Measurement (Page 13-3)
Surface film thick. meas	Screen Used for Surface Film Thickness Measurement (Page 13-14)
Spectr.film thick.meas	Screen Used for Spectral Film Thickness Measurement (Page 13-25)
Comparative Measurement	Screen Used for Comparative Measurement (Page 15-4)
3D-CAD Comparative Measurement	Screen Used for Comparative Measurement (Page 15-4)

# Selecting the Main Image

When you open a new measurement, an image appears in the main image column of the grid sheet. You can select the main image from the following images.

Image type	Description
Laser+Optical	A high-contrast laser image combined with RGB data of a color image.
Optical	This is a color image created using camera focus stacking.
Laser	This is a monochrome all-in-focus image recording the laser reception intensity data when the laser intensity from the sample reaches the maximum value (i.e. when the object lens is in focus).
Laser intens	Image expressing the laser intensity in color
Height	Image expressing the height in color
C-DIC	A high-contrast laser image combined with a differential processed height image.

 Selecting Image Display Type (Page 2-18)



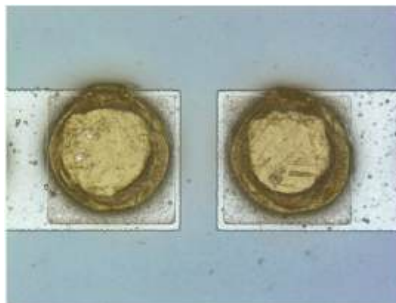
The following describes how to select a type of measurement data and main image.

## Type of Measurement Data

You can select from following types of main image.

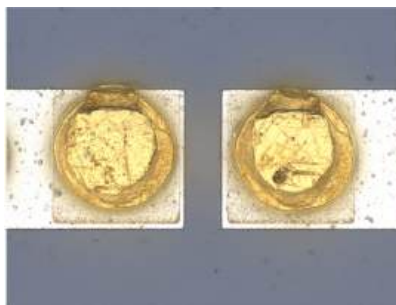
### ■ Laser+Optical

A high-contrast laser image combined with RGB data of a color image.



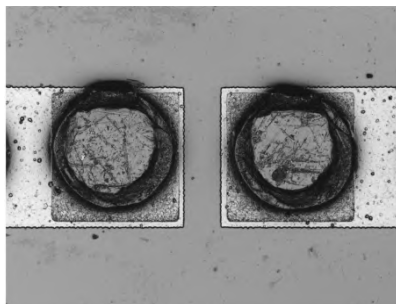
### ■ Optical

This is a color image created using camera focus stacking.



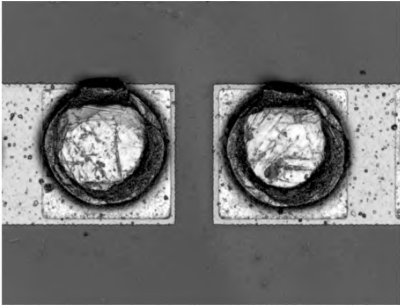
### ■ Laser

This is a monochrome all-in-focus image recording the laser reception intensity data when the laser intensity from the sample reaches the maximum value (i.e. when the object lens is in focus).



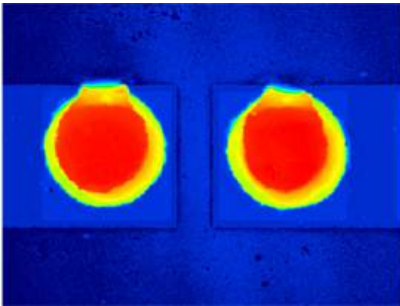
■ **Laser intens**

Image expressing the laser intensity in color



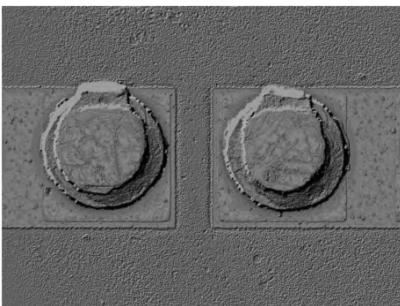
■ **Height**

Image expressing the height in color



■ **C-DIC**

A high-contrast laser image combined with a differential processed height image.



For file types such as measurement result files, refer to Basic File Operations (Page 3-2).

**Selecting Image Display Type**

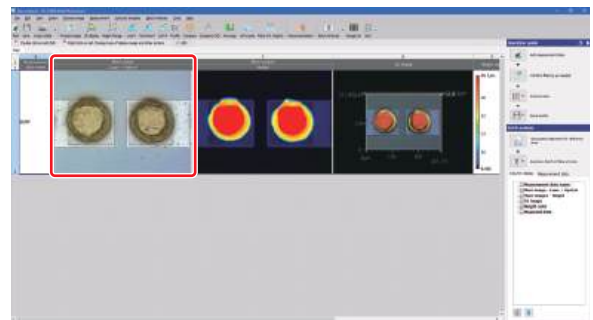
Select a measurement data type for the image displayed as main image.

**1 Open the measurement data.**

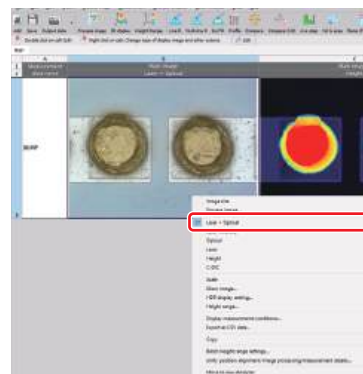
The grid sheet appears.

Opening/Closing File (Page 3-2)

**2 Click the main image.**



**3 With the image selected, use the right-click menu to select the image type.**



Chapter

# 3

## File Management and Creating Reports

This chapter describes basic file operations, how to export data, and how to print.

Basic File Operations .....	Page 3-2
Using Analysis Templates .....	Page 3-6
Report .....	Page 3-9
Exporting .....	Page 3-12
Print .....	Page 3-20

3

File Management and Creating Reports

# Basic File Operations

This section introduces basic file operations (open/close/save) executable from the [File] menu.

From the [File] menu, you can open the following 6 file types.

File format	Description
Grid file (*.cag)	This is the format of measurement analysis files in Multifile Analyzer Software.
VK-X3000 Series Image File (*.vk7)	This is the format of measurement data files for white light interference and spectral film thickness in VK-X3000 Series.
VK-X1000 Series Image File (*.vk6)	These are the measurement data files in focus variation and laser confocal formats in VK-X3000 Series and measurement data in VK-X1000 Series Viewer Software.
Film thickness measurement data in VK-X1000 Series, VK-X250/X150/X120 Series image file (*.vk4)	These are the measurement data files of the film thickness measurement data in VK-X3000/VK-X1000 Series and measurement data in VK-X250/X150/X120 Series Viewer Software.

For more information on file operations, see the following.

📖 Exporting (Page 3-12)

📖 Print (Page 3-20)

## Opening/Closing File

This section describes how to open an analysis result file of the Multifile Analyzer Software or a measurement data file of VK-X3000 Series.

This section will also explain how to close or open an analysis result file.

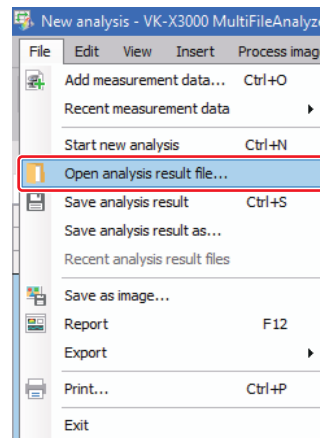
## Opening Analysis Result

**1** Select [Open analysis result file] from the [File] menu.



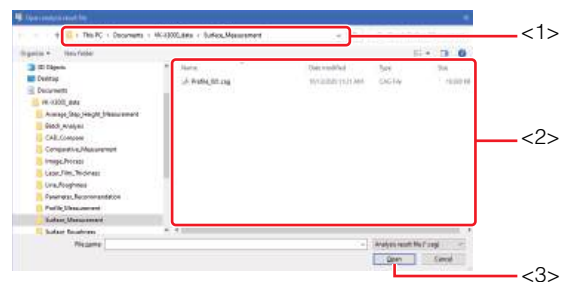
You can also open files as follows:

- Select [Recent analysis result files] from the [File] menu.
- Double-click on an analysis result file.
- Drag and drop a file in the grid view area.



The [Open analysis result file] dialog box appears.

**2** Select the folder containing the file (<1>).

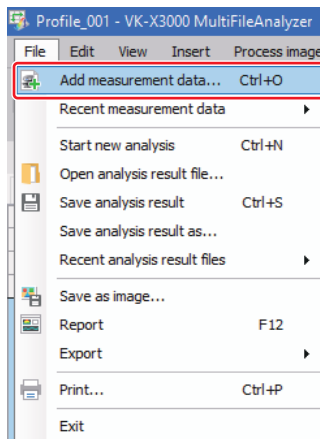


### 3 Select a file from file list (<2>), and click the [Open] button (<3>).

The analysis result of the entire grid sheet saved in the selected analysis result file is displayed in the main window.

## Opening measurement data

### 1 From the [File] menu select, [Add measurement data].

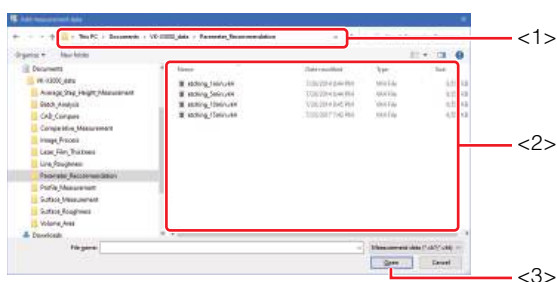


The [Add measurement data] dialog box appears.

**Reference** You can also open files as follows:

- Click on the [Add data] button in the grid view area.
- From the [File] menu, select [Recent measurement data].
- Click the [Add] button in the toolbar.
- Drag and drop a file in the grid view area.

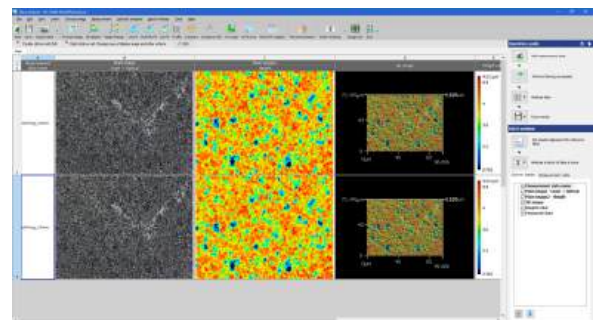
### 2 Select the folder containing the file (<1>).



### 3 Select a file from the list of files (<2>), and click the [Open] button (<3>).

The content of the selected file appears in the main window.

If you continuously open another measurement data file, the measurement data will be added to a row in the grid sheet.

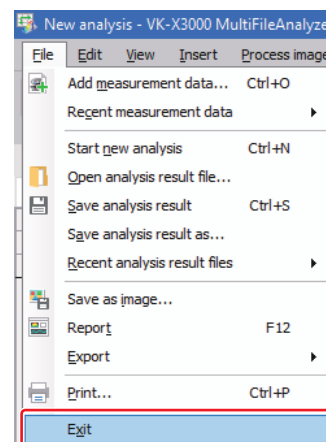


**Reference** You can also select multiple files and open them as a batch.

## Closing analysis result

### 1 Select [Exit] from the [File] menu.

**Reference** You can also close a file by clicking the [x] button at the upper right of the main window.





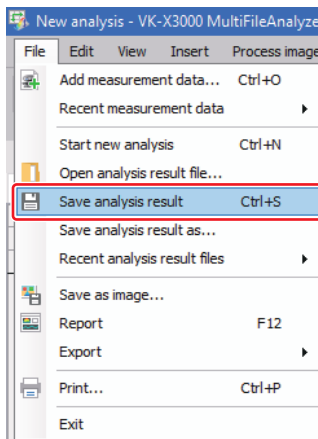
## Saving File

This section describes how to save an analysis result file or an image.

### Saving analysis result file

- 1 From the [File] menu, select [Save analysis result].

 You can also save by clicking the  [Save] button in the toolbar.

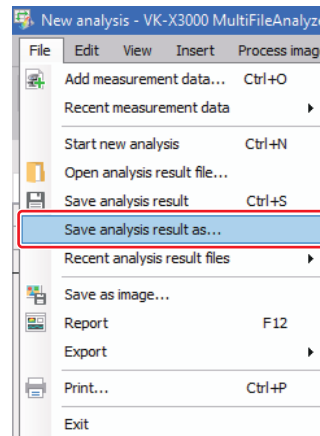


Analyzed contents of all the grid sheets are saved in the analysis result file.

If no contents are saved in the analysis result file, the same operation as "Save analysis result as" will be performed.

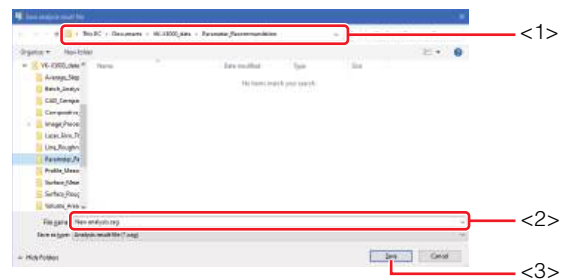
### Saving an analysis result file with a different file name

- 1 From the [File] menu, select [Save analysis result as...].



The [Save analysis result file] dialog box appears.

- 2 Select a destination folder in which to save the file (<1>).



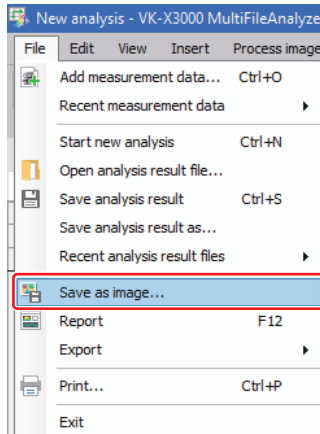
- 3 Enter a new name in the [File name] box (<2>), and click the [Save] button (<3>).

Analyzed contents of all the grid sheets are saved in the analysis result file with a new file name.

## Saving as an image

This section describes how to export the content displayed on the grid sheet as image data. You can save the image data in PNG format, JPEG format or TIFF format.

### 1 From the [File] menu, select [Save as image].

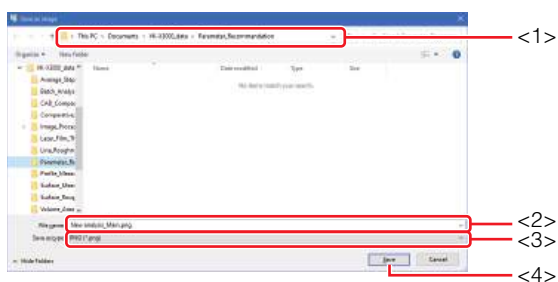


**Reference** You can also save as image by doing the following:

- Select the [Save as image] from the [Output data] button on the toolbar.

The [Save as image] dialog box appears.

### 2 From the list in the [Save as type] box (<3>), select a file format.



#### PNG file (\*.png)

Save display content of grid sheet as PNG file.

#### JPEG file (\*.jpg, \*.jpeg)

Save display content of grid sheet as JPEG file.

#### TIFF file (\*.tif, \*.tiff)

Save display content of grid sheet as TIFF file.

### 3 Select a destination folder in which to save the file (<1>).

### 4 Enter a new name in the [File name] box (<2>), and click the [Save] button (<4>).

**Reference** By default, the file name of the [File name] box is displayed as [Analysis result file name\_Sheet name].

The content shown on the grid sheet is now saved in the selected image file format.

# Using Analysis Templates

3

File Management and Creating Reports

This section describes how to save measurement analysis settings as a template, and then apply the template to measurement data to automatically execute the same measurement analysis processing. You can create a template by saving an analysis result file created in the Multifile Analyzer Software as an analysis template file.

From the [Analysis template] menu, you can open the following type of file.

File format	Description
Analysis template file (*.acs)	This is a template file for the measurement analysis in Multifile Analyzer Software.

## Opening Analysis Template File

This section describes how to open an analysis template file of the Multifile Analyzer Software.

### Applying analysis template

#### 1 Select [Apply] from the [Analysis template] menu.



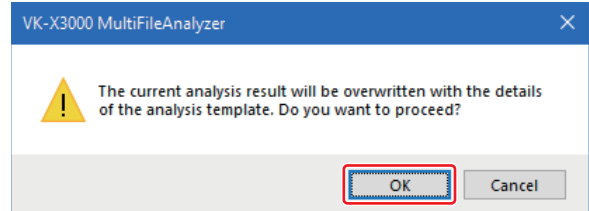
The confirmation message window appears.

**Reference** You can also open analysis files as follows:

- From the [Analysis template] menu, select [Recent analysis templates].
- Drag and drop a file in the grid view area.
- Double-click on an analysis template file.

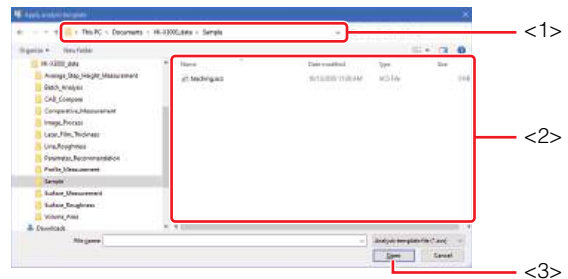
#### 2 Click the [OK] button.

The analysis settings are overwritten.



The [Apply analysis template] dialog box appears.

#### 3 Select the folder containing the file (<1>).



#### 4 Select a file from the list of files (<2>), and click the [Open] button (<3>).

The selected analysis setting will be applied.

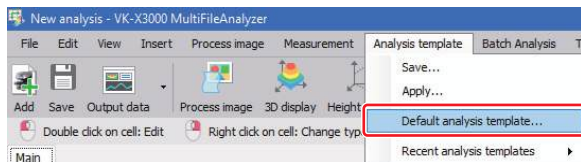
## Processing Measurement Analysis Automatically

This section describes how to set a pre-made template as the default settings. When measurement data is added, these predetermined settings will be applied to the data.

### Setting an analysis template as the default

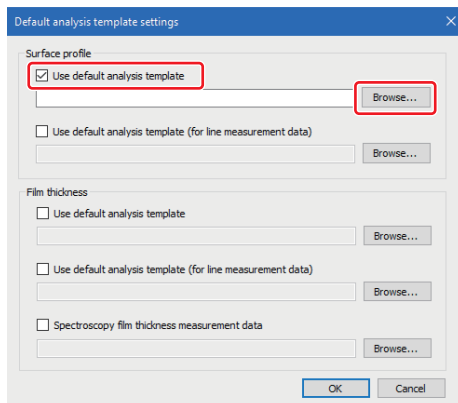
Select an analysis template to use as the default template.

- 1 Select [Default analysis template] from the [Analysis template] menu.



The [Default analysis template settings] dialog box appears.

- 2 Select the checkbox of the analysis template you wish to set, and click the [Browse] button.



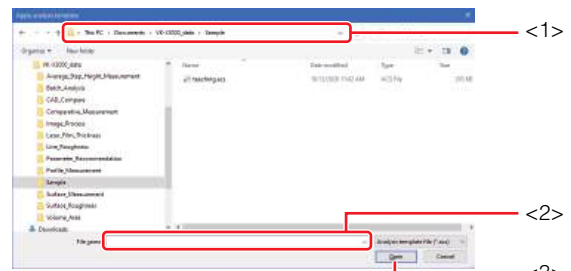
The [Apply analysis template] dialog box appears.



Point

An analysis template can be set for each type of data depending on the mode used to measure.

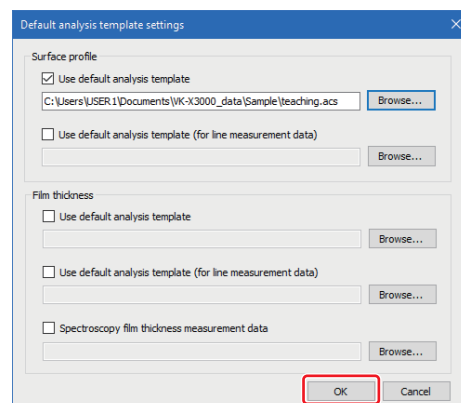
- 3 Select the folder containing the file (<1>).



- 4 Select a file from the list of files (<2>), and click the [Open] button (<3>).

The analysis template file (\*.acs) appears.

- 5 Click the [OK] button.



The selected analysis template is now saved as the default template. Next time you start the Multifile Analyzer Software, measurement analysis will be performed using this default analysis template.



Point

- The existing setting will be maintained if the Multifile Analyzer Software is finished.
- The auto position alignment setting is necessary to analyze the measurement data correctly.

📖 Auto Position Alignment (Page 5-34)

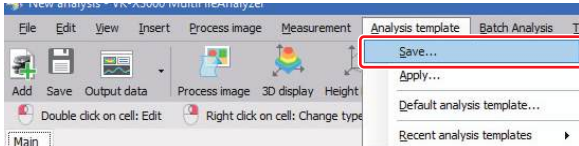
## Saving Analysis Template File

This section describes how to save the measurement analysis settings in an analysis template file. You can also set the settings as default settings.

- 4** Enter a new name in the [File name] box (<2>), and click the [Save] button (<3>).

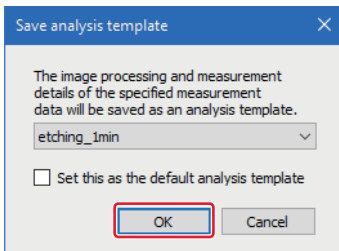
The measurement analysis settings are now saved as an analysis template file with a new name.

- 1** Select [Save] from the [Analysis template] menu.



The [Save analysis template] dialog box appears.

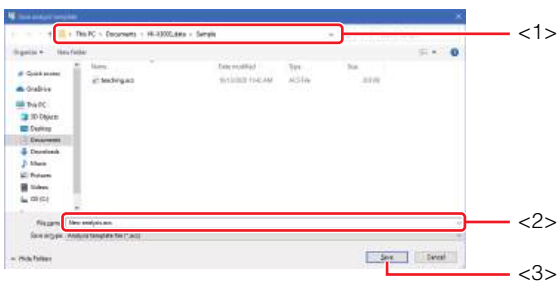
- 2** Select the measurement data on which the measurement analysis is to be saved, and click the [OK] button.



If you select the [Set this as the default analysis template] checkbox, the analysis template file you are saving will be set as the default analysis template.

Setting an analysis template as the default (Page 3-7)

- 3** Select a destination folder to save the file (<1>).



# Report

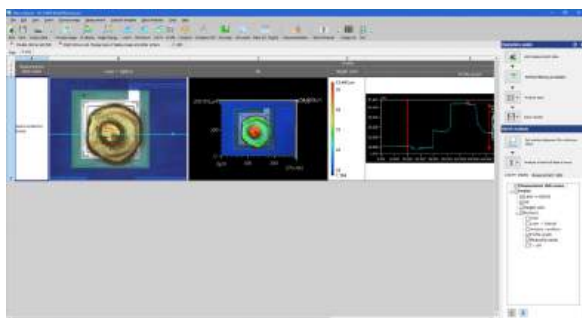
This section describes how to display a report of measurement results by the Multifile Analyzer Software in another window.

You can edit the layout of the report and print it out.

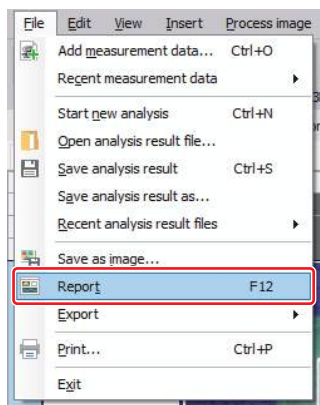
## Displaying Report

This section describes how to display a report of measured data by the Multifile Analyzer Software.

- 1 Select the grid sheet including the measurement data you wish to display in report, and select the measurement result.



- 2 Select [Report] from the [File] menu.



**Reference** You can also display the report as follows:

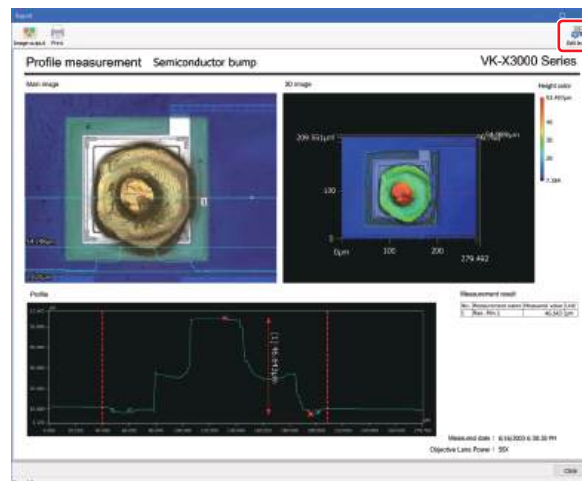
- Select [Report] from the [Output data] button on the toolbar.
- Select the measurement result, and select [Report] by right-clicking.

The [Report] screen appears.

## Editing Report Layout

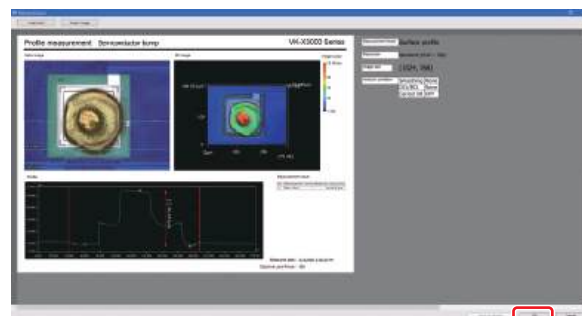
The report layout can be edited.

- 1 Select the [Edit layout] button.



The [Edit report layout] screen appears.

- 2 Edit layout, and click the [OK] button.

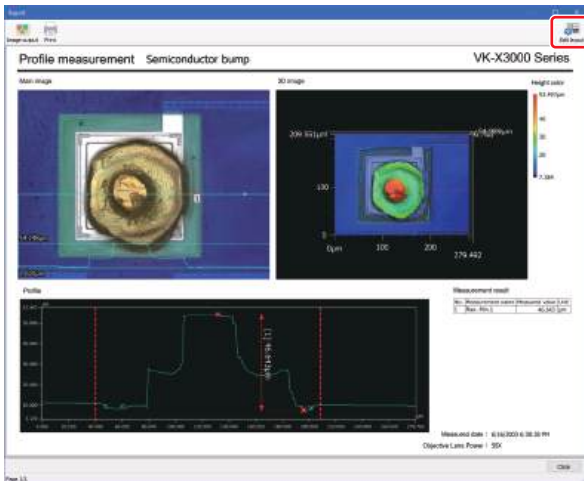


- Reference** • Click the [Insert text] button to insert the text box.
- Select an image and right click it, a menu related to layout editing will appear.
- Click the [Insert image] button to insert the image.
- Click the [Back to default] button to return to default.

The report layout is edited.

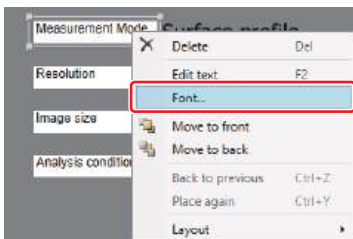
## Changing the Text Font

1 Select the [Edit layout] button.



The [Edit report layout] screen appears.

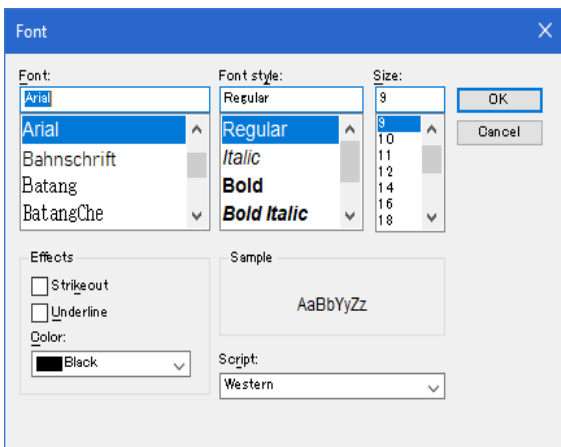
2 Select the [Font] from the right-click menu of the text box.



The [Font] screen appears.

**Reference** The font of the result display of the measurement value cannot be changed.

3 Edit the font size, color, and style, and click the [OK] button.

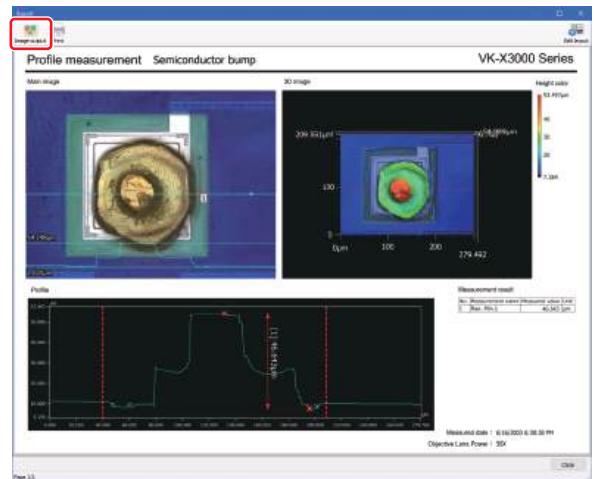


## Exporting Report

The created report can be printed or output as an image.

### Exporting Report as Image

1 Select the [Image output] button.



The [Output report] dialog box appears.

2 Set the following items.



**[All pages] radio button**

All pages are output.

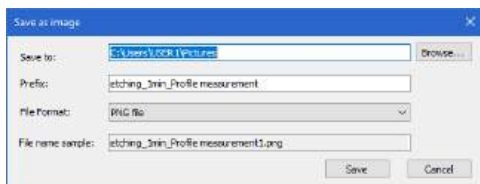
**[Pages within selected range] radio button**

Select the pages to output from [Start page] box and [Finish page] box.

3 Click the [Output] button.

The [Save as image] dialog box appears.

**4 Set the following items.**



**[Save to] box**

Select a folder where you can save the output data.

**[Prefix] box**

Set the prefix for all the output data to be created.

**[File Format] pull-down list**

Select the file format of the output data.

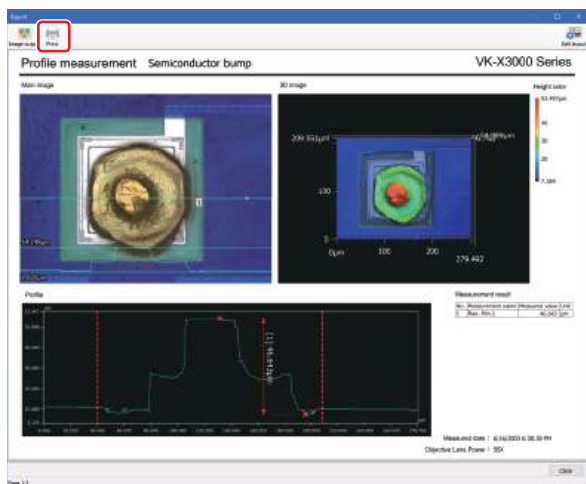
- PNG file
- JPEG file
- TIFF file

**5 Click the [Save] button.**

The image is output.

**Printing Report**

**1 Select the [Print] button.**



The [Output report] dialog box appears.

**2 Set the following items.**



**[All pages] radio button**

All pages are output.

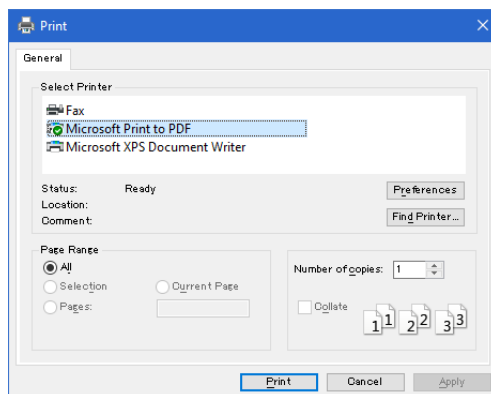
**[Pages within selected range] radio button**

Select the pages to output from [Start page] box and [Finish page] box.

**3 Click the [Output] button.**

The [Print] dialog box appears.

**4 If necessary, change the print settings.**



**5 Click the [Print] button.**

Printing is executed.

# Exporting

This section introduces data exporting operations executable from the [File] menu.

## Exporting to a CSV File

With Multifile Analyzer Software, you can save the content of a grid sheet in CSV format. Data in CSV format can be imported into spreadsheet software such as Microsoft Excel.

The procedures are different depending on the output data.

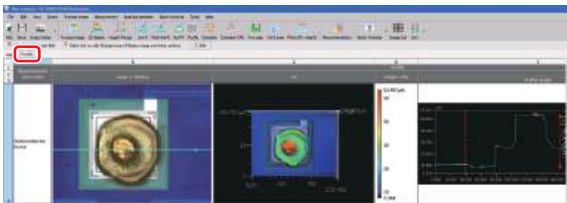
### Exporting Grid Sheet or Main Image

The measured values, images, graphs, and tables inside the grid are output.

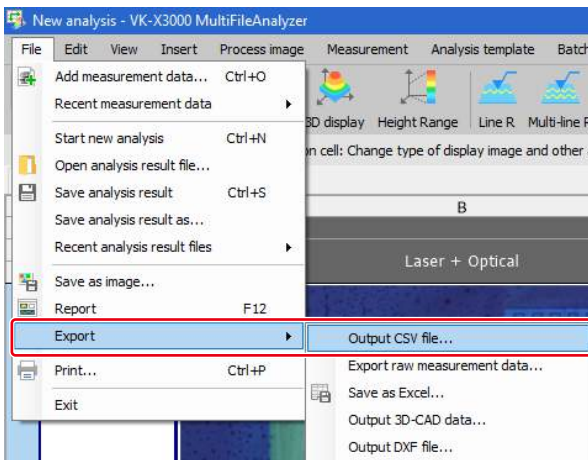
3

File Management and Creating Reports

- 1 Select the grid sheet including the data you wish to save in CSV format.

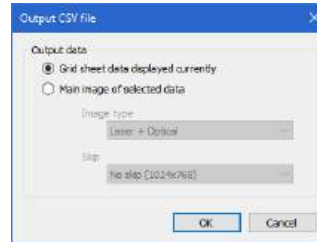


- 2 Select [Export] from the [File] menu, and then select [Output CSV file].



The [Output CSV file] dialog box appears.

- 3 Set the following items.



#### [Grid sheet data displayed currently] radio button

This section describes how to output the currently displayed grid sheet.

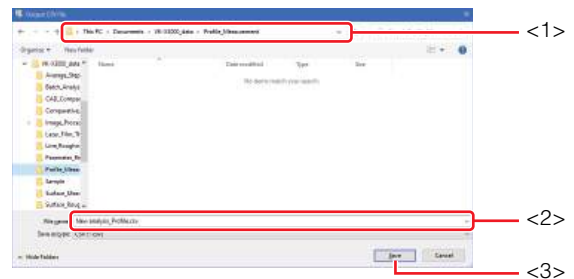
#### [Main image of selected data] radio button

Outputs the main image of the selected data. It sets the output data from the [Image type] pull-down list and [Skip] pull-down list.

- 4 Click the [OK] button.

The [Output CSV file] dialog box appears.

- 5 Select a destination folder for CSV file (<1>).



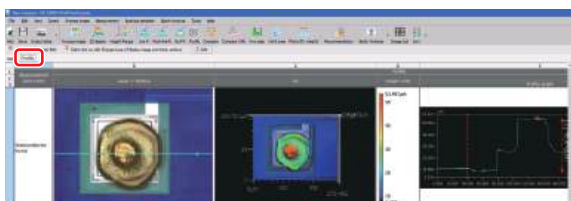
- 6 Enter a file name in the [File name] box (<2>), and click the [Save] button (<3>).

The content of the grid sheet or the main image is now saved in CSV format.

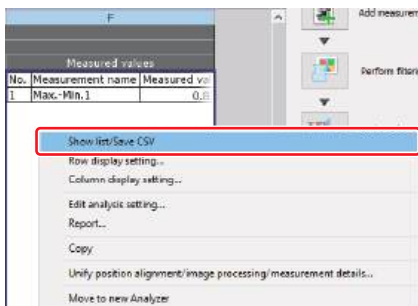
## Exporting measurement result

The selected measurement result is exported as a CSV file.

- 1 Select the grid sheet including the measurement data you wish to save in CSV format.

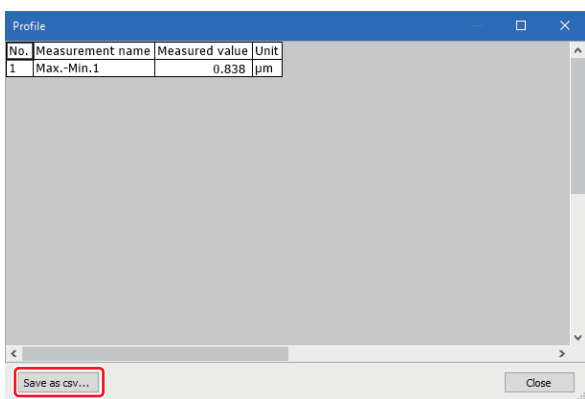


- 2 Select a measurement result and then [Show list/Save CSV] by right clicking.



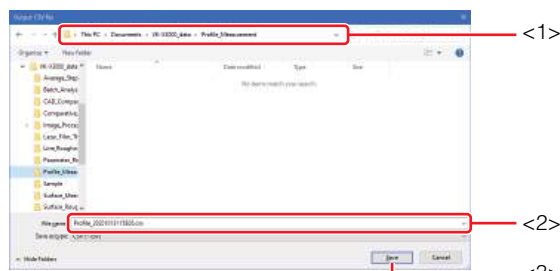
A dialog box displays CSV contents appears.

- 3 Click the [Save as csv] button.



The [Output CSV file] dialog box appears.

- 4 Select a destination folder for CSV file (<1>).



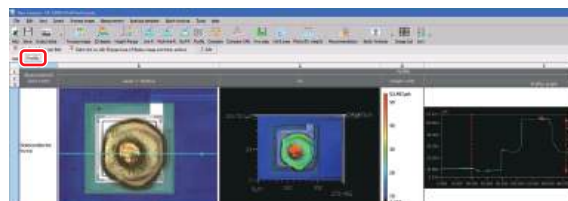
- 5 Enter a file name in the [File name] box (<2>), and click the [Save] button (<3>).

The contents of the grid sheet is now saved in CSV format.

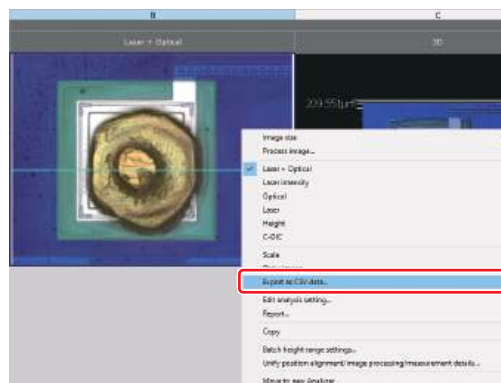
## Exporting Selected Image Contents

Information such as measurement date and image color value can be exported as a CSV file.

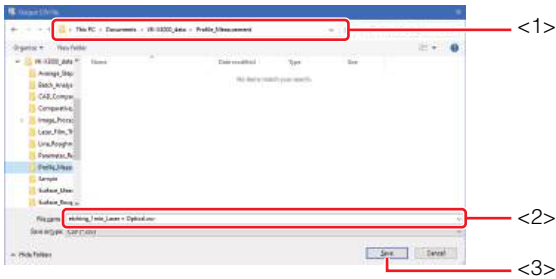
- 1 Select the grid sheet including the data you wish to save in CSV format.



- 2 Select an image, then select [Export as CSV data] by right clicking.



**3 Select a destination folder for CSV file (<1>).**

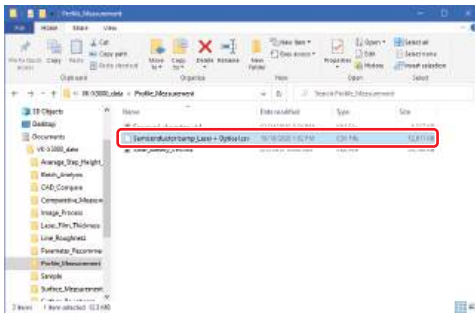


**4 Enter a file name in the [File name] box (<2>), and click the [Save] button (<3>).**

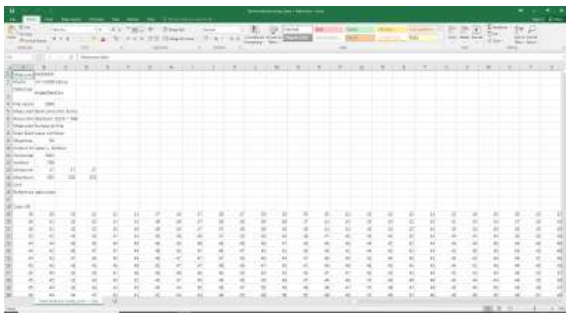
The content of the image is now saved in CSV format.

**Opening a CSV file**

**1 Double-click on a CSV file from the Explorer.**



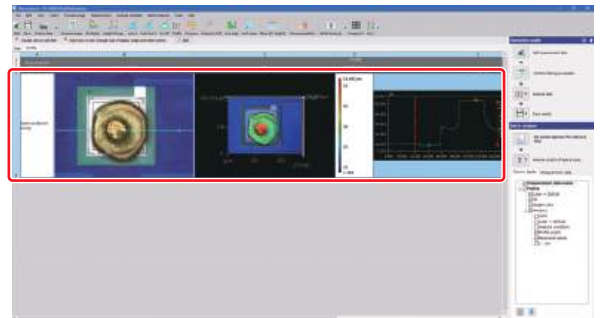
Microsoft Excel (or other spreadsheet software) starts and displays the content of the CSV file.



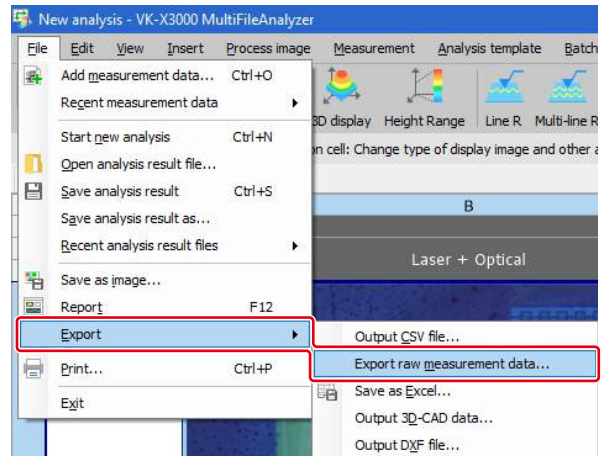
**Exporting Raw Height Data**

Added measurement data can be exported as a raw, unaltered file. Image processing performed in Multifile Analyzer Software are not applied.

**1 Select the measurement data to output.**

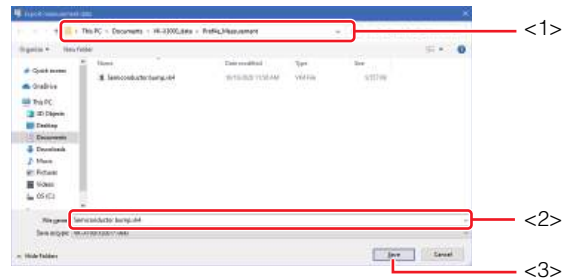


**2 Select [Export] from the [File] menu, and then select [Export raw measurement data].**



The [Export measurement data] dialog box appears.

**3 Select a destination folder to save the vk file (<1>).**



**4 Enter a file name in the [File name] box (<2>), and click the [Save] button (<3>).**

The measurement data is now saved in the same vk file when being added to Multifile Analyzer Software.

## Exporting as Excel File

The content of the grid view area is output to Excel file in unaltered form.

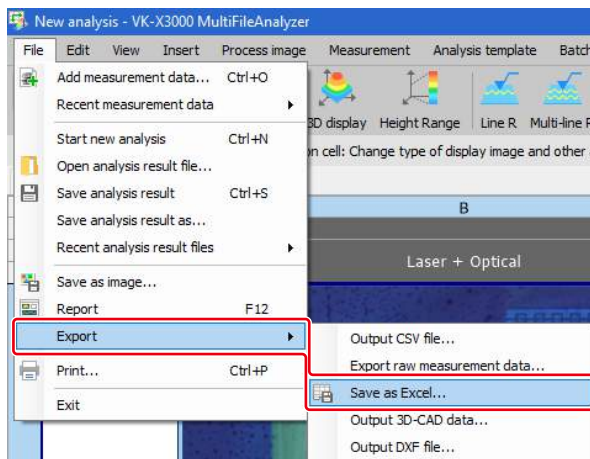
### Point

- The file is saved as an Excel workbook (\*.xlsx). This extension is the standard file format for Excel 2007 and later.
- When you export to an Excel file, images, graphs, tables within cells and all other content of the grid sheet is output in unaltered form. Before performing the output, adjust the size of the grid sheet.

### 1 Select the grid sheet to output.



### 2 Select [Export] from the [File], and then select [Save as Excel].



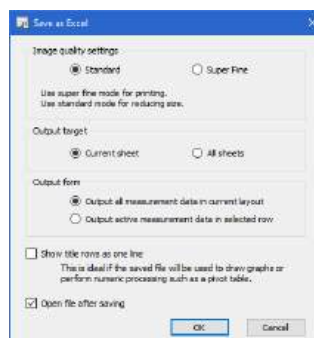
### Reference

You can also output as Excel file by doing the following:

- Select [Save as Excel] from the [Output data] button on the toolbar.

The [Save as Excel] dialog box appears.

### 3 Set the following items.



#### [Image quality settings] radio button

With [Standard], images are output at a resolution of 96 dpi. With [Super Fine], the resolution is 600 dpi.

#### [Output target] radio button

With [Current sheet], only the selected grid sheet is output. With [All sheets], the content of all the grid sheets is output. Once output, the names of each grid sheet tab will become the names of each worksheets in Excel.

#### [Output form] radio button

[Output all measurement data in current layout] outputs all the measurement data inside the grid sheet in Multifile Analyzer Software layout; and [Output active measurement data in selected row] outputs one of the selected measurement data in a layout easy to analyze.

### Reference

When [Output active measurement data in selected row] is selected, the font information of measurement result are not output.

#### [Show title rows as one line] checkbox

When this is selected, merging of the cells in the heading row is cleared and the grid sheet is output with separate cells.

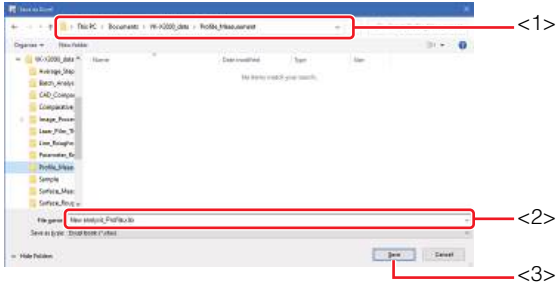
#### [Open file after saving] checkbox

When this is selected, the file is opened in Excel file after the output.

### 4 Click the [OK] button.

The [Save as Excel] dialog box appears.

**5 Select a destination folder in which to save the Excel file (<1>).**

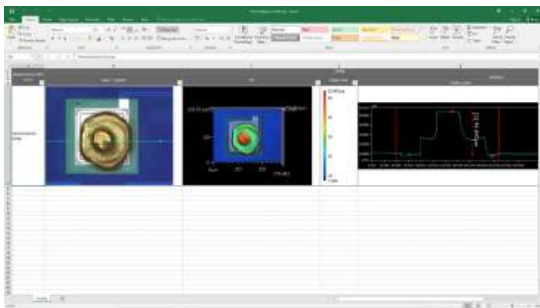


**6 Enter a file name in the [File name] box (<2>), and click the [Save] button (<3>).**

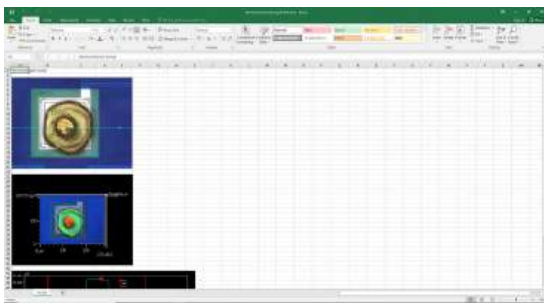
The content of the grid sheet is now saved in an Excel file.

If you selected the [Open file after saving] checkbox in the [Save as Excel] dialog box, the saved file is displayed.

- When [Output all measurement data in current layout] is selected



- When [Output active measurement data in selected row] is selected



**Exporting 3D-CAD data**

The height data of a sample can be saved to 3D-CAD data (STL file, STEP file) or ASCII file with the Multifile Analyzer Software. These 3D-CAD data files may be opened with 3D-CAD software.

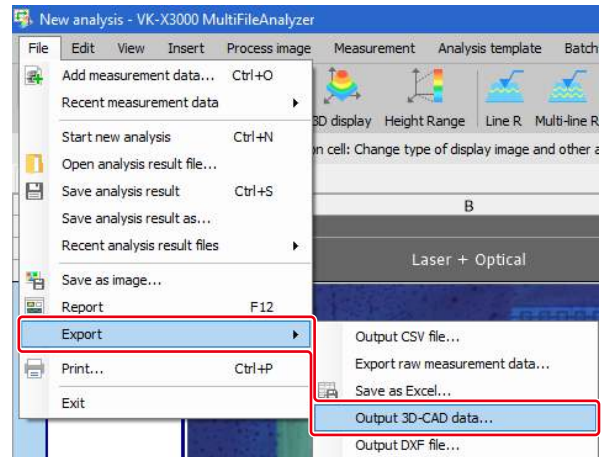
**Important** When it takes a long time to read the 3D-CAD file or if the file cannot be opened, try the following methods:

**If the file contains a large amount of unnecessary data, this can create a great load on the 3D-CAD system. Try to avoid as much unnecessary data as possible.**

**If a missing point is set in "Set invalid area" of image processing, places such as stage plane which is unnecessary to output as 3D-CAD data can be excluded from the output target.**

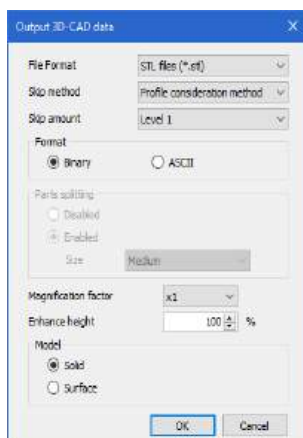
📖 Set invalid area (Page 5-28)

**1 Select [Output 3D-CAD data] from [Export] of the [File] menu.**



The [Output 3D-CAD data] dialog box appears.

## 2 Set the following items.



### [File Format]

Select a file format from [STL files], [STEP files] and [ASCII files].

### [Skip method]

Select the skip method of data from [Simple skip] and [Profile consideration method].

### [Skip amount]

Select a skip level of data from [None], [1/2], [1/4], [1/8], [1/16], and [1/32] for the simple skip, or [None] and [Level 1] - [Level 30] for the profile consideration method.

### [Format]

Select a format for the output data from [Binary] and [ASCII].

**Reference** [Format] can be selected only when [File Format] is set to [STL files].

### [Parts splitting]

Split height data into multiple parts.

Disabled: Parts splitting is disabled.

Enabled: Parts splitting is enabled.

Select the amount of parts after being split by size.

Large: Make split size large. (The amount of parts is small.)

Medium: Somewhere between large and small.

Small: Make split size small. (The amount of parts is large.)

**Important** When it takes long to read the file, or the file cannot be opened, try the following methods.

- Split parts.
- Make parts size smaller.
- Increase Skip amount.

**Note:** Import settings of a 3D-CAD software also influences the time required to read a file.

**Reference** [Parts splitting] can be selected only when [File Format] is set to [STEP files].

### [Magnification factor]

Select a magnification factor of XYZ scale from [x1], [x10], [x100], and [x1000].

### [Enhance height]

Set to emphasize the bumps in a nearly flat sample. The magnification factor can be set between 10 to 10,000%.

The actual magnification factor will be the product of this value and the XY direction magnification factor.

### [Model]

Select solid model or surface model.

Use solid model in normal situations.

**Important**

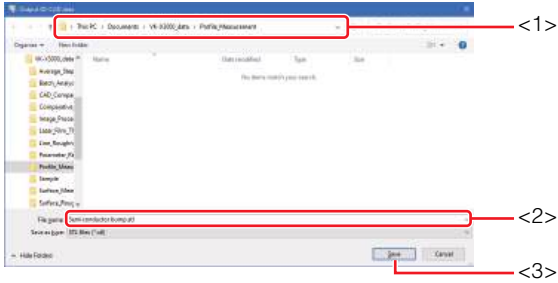
- When converting a file whose number of data pixels exceeds 4096 to a STEP file, decrease the data size so that the number of pixels will decrease to 4096 or less.

- When the surface model is selected, its shape seen from the back side can be confirmed by 3D-CAD.

## 3 Click the [OK] button in the [Output 3D-CAD data] dialog box.

The [Output 3D-CAD data] dialog box appears.

- 4 Select a destination folder in which to save the 3D-CAD data or STEP files (<1>).



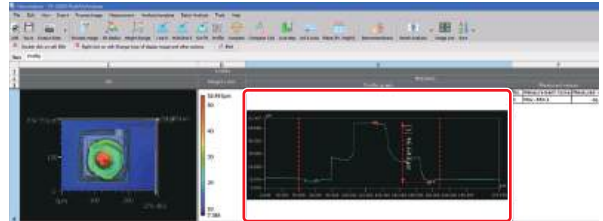
- 5 Enter a new name in the [File name] box (<2>), and click the [Save] button (<3>).

The height data is written into the specified file format and saved to a file.

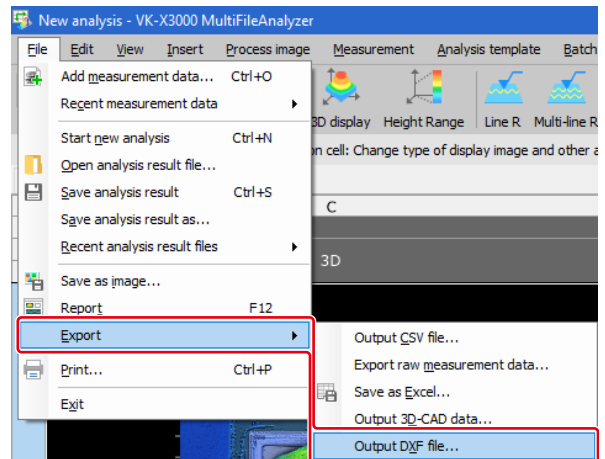
## Exporting DXF File

Outputs the profile graph directly. This feature is not available in film thickness mode.

- 1 Select the profile graph to export.



- 2 Select [Export] from the [File] menu, and then select [Output DXF file].

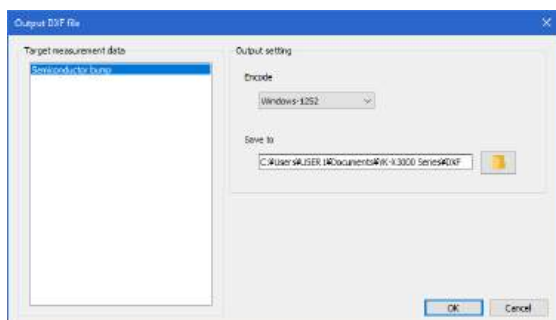


The [Output DXF file] dialog box appears.

**Reference** You can also display the report as follows:

- Select a profile graph, then select [Output DXF file] by right clicking.

### 3 Set the following items.



#### [Target measurement data]

Select the target measurement data.

#### [Encode]

Selects the encoding from Shift-JIS or UTF-8.

#### [Save to]

Select the output destination.

### 4 Click the [OK] button in the [Output DXF file] dialog box.

The profile graph is saved as DXF file.

# Print

This section introduces printing-related operations executable from the [File] menu.

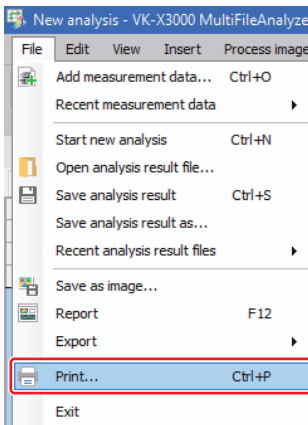
**Important** Before printing, connect the printer to the PC and install the printer driver.

## Printing

If necessary, change print orientation, magnification, etc.

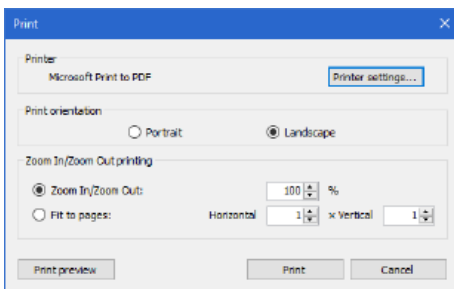
- Point**
- Preview the grid sheet you intend to print.
  - It is not possible to print multiple grid sheets in a batch. Please print the grid sheets one at a time.

### 1 Select [Print] from the [File] menu.



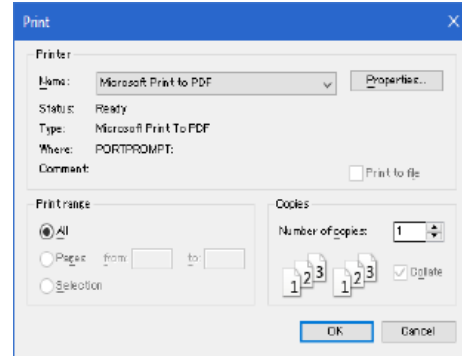
The [Print] dialog box appears.

### 2 If necessary, change the print settings.



### [Printer]

In the dialog box that appears upon clicking the [Printer settings] button, set the printer, printing range and number of copies.



### [Print orientation]

Select print orientation by clicking the [Portrait] or [Landscape] option buttons.

### [Zoom In/Zoom Out printing]

To set magnification, click the [Zoom In/Zoom Out] option button and set a value. To fit to the number of printed pages, click the [Fit to pages] option, and select the number of vertical or horizontal pages. The magnification will be automatically adjusted to the set number of pages.

### [Print preview] button

On clicking, the [Print preview] dialog box appears.



### 3 Click the [Print] button.

Printing is executed.

## Image Display

This chapter describes image display settings which can be executed in the [3D display] dialog box and the image list display window.

Image Display .....	Page 4-2
Configuring Image Display .....	Page 4-4
Displaying Measurement Conditions .....	Page 4-13

# Image Display

This section describes the image display.

## Displaying the Image List

This section describes how to display images of measurement data added to Multifile Analyzer Software aligned in separate windows.

The Image List function will display up to 9 files, beginning with the files opened near the top of the grid sheet. The image displayed will either be the main image or a 3D image.

4

Image Display

### 1 From the [Tools] Menu, select [Image list].

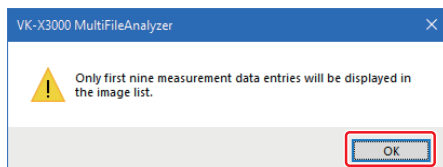


**Reference** You can also open files as follows:

- Click the [Image list] button in the toolbar.

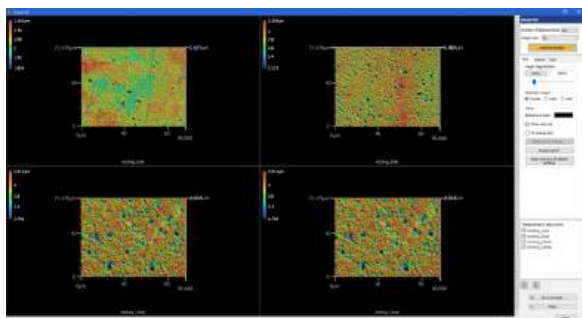
**Point**

- A message is displayed if there are 10 or more sets of measurement data. Click the [OK] button.



- Hidden measurement data is not displayed in the image list.

The image list display window appears.

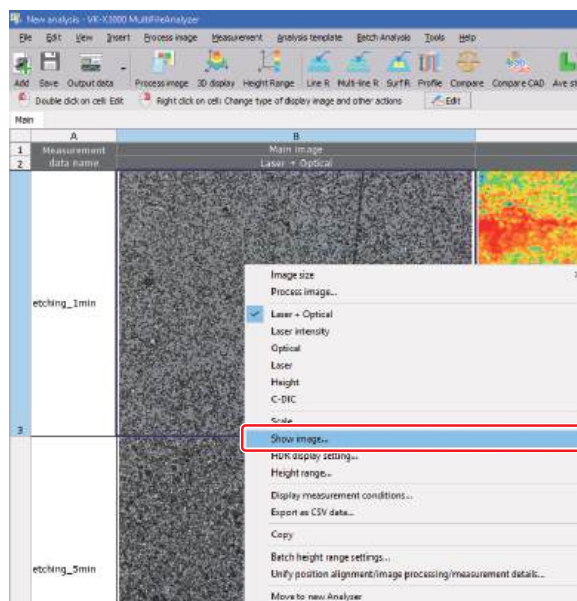


For more information about configuring the display, see [Configuring Image Display \(Page 4-4\)](#).

## Checking/Configuring the Main Image

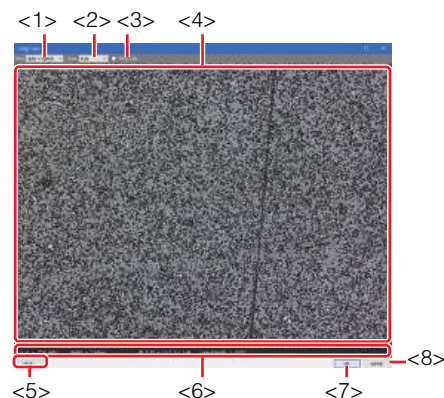
This section describes how to configure the display of the main image in the grid sheet. You can enlarge the images on the grid sheet to check them.

### 1 Select [Show image] from the right-click menu.

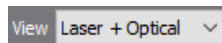


**Reference** You can also open the [Image view] dialog box by double-clicking the main image of the main sheet.

Once selected, the [Image view] dialog box appears.



#### <1> [View] box



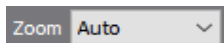
Select the type of image to display in the main image column.

[Selecting the Main Image \(Page 2-17\)](#)



If the information required for the display is not contained in the measurement data, no image is displayed.

## <2> [Zoom] box



You can select a zoom level for the image.



Rotate the mouse wheel to change the zoom level.

## <3> [Show scale] checkbox

Select whether or not to show the scale. The position and size of the scale is determined automatically.

## <4> Image display area

The image is displayed in this area.

## <5> [Save...] button

Once selected, the [Save as] dialog box appears.

The main image is saved. Select the file format from among PNG file format (\*.png), JPEG file format (\*.jpg, \*.jpeg) or TIFF file format (\*.tif, \*.tiff).

## <6> Status bar

Displays the X and Y coordinates of the mouse pointer when positioned over the image display area, as well as the height, RGB value, and laser intensity.

## <7> [OK] button

By clicking [OK], the [Image view] dialog box closes and the settings are applied to the main image column.

## <8> [Cancel] button

Click to close the [Image view] dialog box without applying the settings.

## 2 Select an image in the [View] box.

## 3 Select a zoom level in the [Zoom] box.



The entire image is displayed on the grid sheet irrespective of the zoom level.

## 4 Use the [Show scale] checkbox to show/hide the scale.

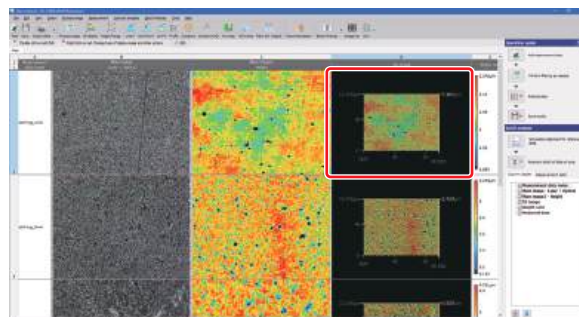
Select to show the scale.

## 5 Click the [OK] button.

Close the [Image view] dialog box.

## Checking/Configuring a 3D Image

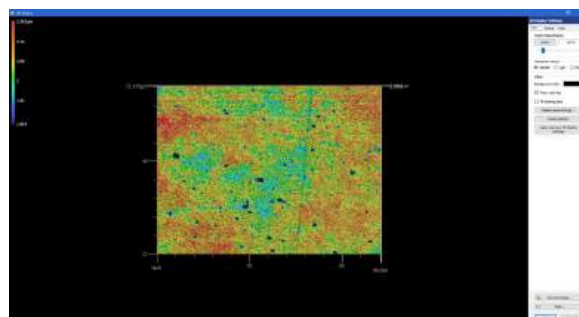
### 1 Double-click a 3D image.



You can also open the [3D display] dialog box as follows:

- Select [3D display] from the [View] menu.
- Click the [3D display] button in the toolbar.
- Select a 3D image, and select [3D display settings...] from the right-click menu.

The [3D display] dialog box appears.



For more information about configuring the display, see [Configuring Image Display \(Page 4-4\)](#).

# Configuring Image Display

This section describes the image list display window, and the various display settings of the [3D display] dialog box.

## Configuring Image Display

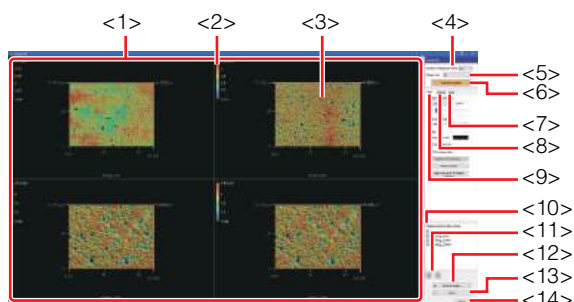
In this section, an example of the image list display window is described.

4

Image Display

### 1 From the [Tools] Menu, select [Image list].

The image list display window appears.



#### <1> Entire image display area

This area displays the image list of measurement data. It is displayed according to the settings in the [Number of displayed items] box and the [Image type] box.

Point

In the [3D display] dialog box, a 3D image is displayed.

#### <2> Color bar

The heights of the 3D image are represented in different colors. On the right side of the bar, height values corresponding to the colors are displayed.

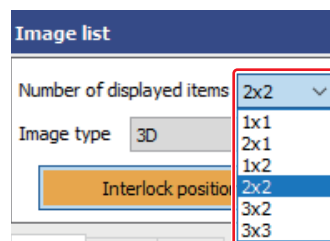
#### <3> Image display area

This area displays images of the measurement data.

Point

In the image list display window, the measurement data names are displayed under the images.

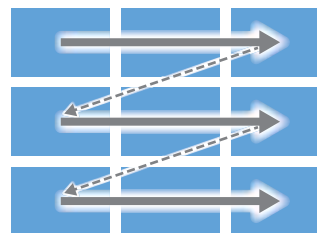
#### <4> [Number of displayed items] box



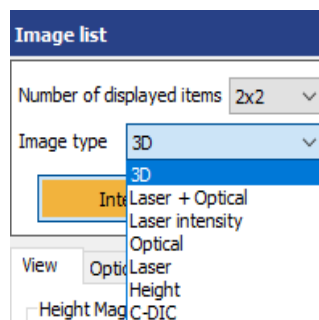
Select the number of images to display in 1 window using the numbers of rows and columns rows x columns. The default state is [2x2]. If the images cannot be displayed in 1 window, the scroll bar will be displayed.

Point

- The images are displayed one after another, starting at the top of the grid sheet in the following orientation:



#### <5> [Image type] box



Select an image. The default state is [3D].

#### <6> [Interlock position] button

This checkbox is displayed if you have selected [3D] as the image type. Select to apply the rotations, enlargements/reductions and movements performed on any selected image to all the images.

#### <7> [Tools] tab

This checkbox is displayed if you have selected [3D] as the image type.

Select this tab to display a scale with the 3D image, and save/load 3D image position information.

**<8> [Optical] tab**

This checkbox is displayed if you have selected [3D] as the image type.

Select this tab to select the texture material to be displayed and adjust the lighting effects.

**<9> [View] tab**

This checkbox is displayed if you have selected [3D] as the image type.

Select this tab to change the height magnification of the 3D image, or configure the display area.

**<10> [Measurement data name] check box**

Click the check box to display or hide the measurement data.



Up to nine pieces of data can be displayed.

**<11> [Move up/Move down] button**

With a measurement data row selected, click these buttons to change the order of the measurement data.

**<12> [Save as image] button**

Click to save the range depicted in the entire image display area. Portions extending out of the window are not saved. Select the file format from among PNG file format (\*.png), JPEG file format (\*.jpg, \*.jpeg) or TIFF file format (\*.tif, \*.tiff).

**<13> [Print] button**

Print the range displayed in the entire image display area.

Portions extending out of the screen are not printed.

**<14> [Close] button**

Closes the image list display window.

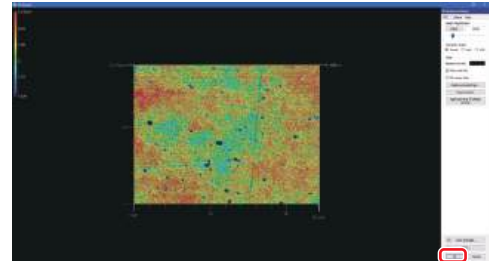


**When other than [3D] is selected in the [Image type] box, the following settings are not displayed, and so the operations from Step 2 onwards are not available.**

- <6> [Interlock position] button
- <7> [Tools] tab
- <8> [Optical] tab
- <9> [View] tab

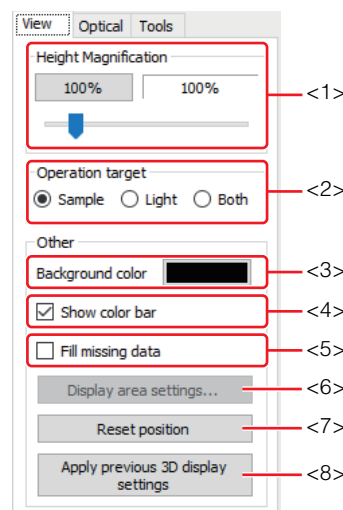


An [OK] button is displayed in the [3D display] dialog box.



After clicking the [OK] button, the [3D display] dialog box closes and the settings are applied to the 3D image on the grid sheet.

**2 Select the [View] tab to set the following items.**



**<1> Height magnification**

Drag the slider to set the image height magnification of a 3D image (0 to 50000%).

**[100%] button**

Sets the height magnification to 100%.



When the magnification is 100%, the ratio of the XY direction lengths and the height direction lengths of the 3D display is 1:1.

**<2> Operation target**

Select the operation to be performed when dragging images in the 3D image display area.

**[Sample] radio button**

Changes the orientation of the sample in 3D display.

**[Light] radio button**

Changes the light orientation.

**[Both] radio button**

Changes the orientation of both the sample and the light simultaneously.

**<3> [Background color] color palette**

Click to use the displayed color palette to select the background color for 3D image.

**<4> [Show color bar] checkbox**

Select to show the color bar in the 3D image display area.

**<5> [Fill missing data] checkbox**

Select to display the missing data on the 3D image.

**<6> [Display area settings] button**

Click to use the displayed [Area settings] window to specify the display area of the 3D image.



Click the [Display area settings] button in the image list display window.

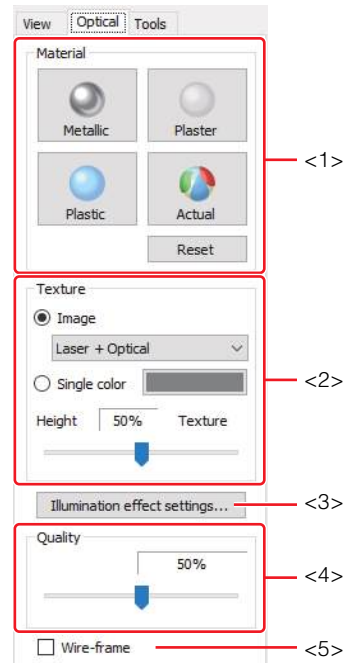
**<7> [Reset position] button**

Click to reset the settings of the 3D image, such as height magnifications and positions, to the state at the time of opening the [3D display] dialog box.

**<8> [Apply previous 3D display settings] button**

Reproduces the 3D settings such as height magnification or position for 3D image set for other image files.

**3 Select the [Optical] tab to set the following items.**

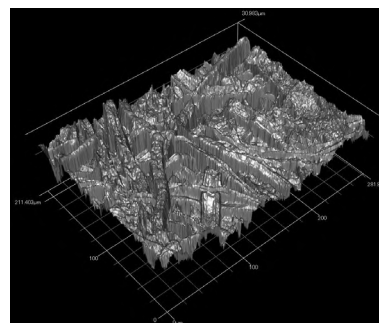


**<1> Material**

Select the texture material of the 3D image from [Metallic], [Plaster], [Plastic], and [Actual].

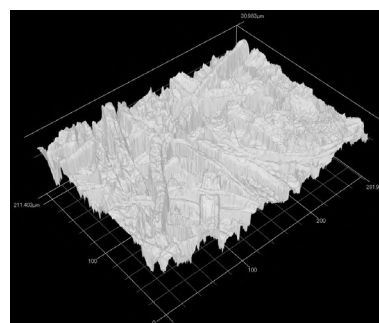
**[Metallic] button**

Set the 3D image texture to the material illustrated below.



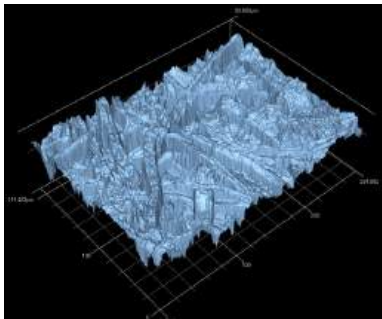
**[Plaster] button**

Set the 3D image texture to the material illustrated below.



**[Plastic] button**

Set the 3D image texture to the material illustrated below.

**[Actual] button**

Set the 3D image texture to the material illustrated below.

**[Reset] button**

Resets the material you specified.

**<2> Texture****[Image] radio button**

Displays the 3D image with the selected image.

**[Single color] radio button**

Displays the 3D image in the selected color.

**[Height]**

Drag the slider to adjust the mixing ratio between the height image and the texture (0-100%).

**<3> [Illumination effect settings] button**

Click to and use the displayed [Illumination effect settings] dialog box to specify illumination effects for the 3D image.

**ON/OFF** : Turn on or off the light effect. Select ON to set the following advanced conditions.

**Light** : Adjust the strength of the light source using the slide bar.

**Ambient** : Adjust the ambient brightness.

**Mirror** : Adjust the glossiness of the 3D image surfaces using the slide bar.

**Focus** : Set the light focus level for the spot light from the source.

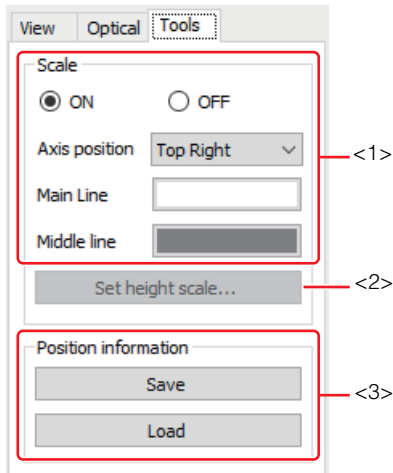
**<4> [Quality]**

Drag the slider to adjust the texture quality (0-100%).

**<5> [Wire-frame] checkbox**

When this checkbox is selected, the 3D image is displayed in wire frames, where data points are represented by intersection points.

**4 Select the [Tools] tab and configure each setting.**



**<1> Scale**

Specify the color for the cursors displayed in the 3D image display area.

**[ON]/[OFF] radio button**

Select or clear to display/hide the scale.

**[Axis position]**

Select the height axis position from "Upper right", "Upper left", "Lower right", and "Lower left".

**[Main Line] color palette**

Click, and use the displayed color palette to select the color of the scale (main line).

**[Middle line] color palette**

Click, and use the displayed color palette to select the color of the scale (middle line).

**<2> [Set height scale] button**

Click, and use the displayed [Set height scale] dialog box to automatically or manually specify the scale interval.



Click the [Display area settings] button in the image list display window.

**<3> Position information**

Save or load the position settings (angle and direction) of the 3D image.

**[Save] button**

Click to save the position information as a 3D position information file in XML format (\*.xml) with a new name. When this button is clicked, the [Save as] dialog box appears.

**[Load] button**

Click to load 3D position information in XML format (\*.xml) and apply the position information in the 3D display.

When this button is clicked, the [Open] dialog box appears.

**5 Click the [Close] button in the image list display window.**

The image list display window closes.

## Settings for Displaying a Height Image

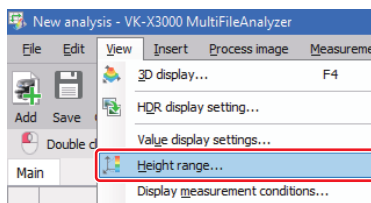
This section describes how to configure the settings for converting height data to RGB values from the specified color palette (8 bit for each color) and how to display the results.

### 1 Open the analysis result file or measurement data.

The grid sheet appears.

Opening/Closing File (Page 3-2)

### 2 Select [Height range] from the [View] menu.

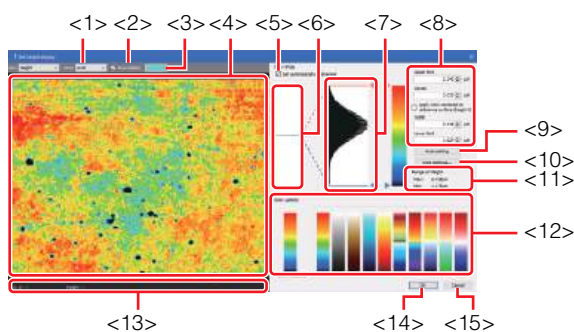


You can also open the [Set height display] dialog box as follows.

- Click the [Height range] button in the toolbar.
- Select 1 main image, and then [Height range] from the right-click menu.

The [Set height display] window appears.

If you have selected multiple sets of measurement data, the first measurement data appears.



#### <1> [Zoom] box

You can select a zoom level for the image.

#### <2> [Area display] checkbox

Select to display the range set in the area settings.

#### <3> [Area color] color palette

Set the display color for the range set in the area settings.

#### <4> Image display area

The image is displayed in this area.

#### <5> [Set automatically in all areas] checkbox

Select to return the configured area to the default, and set the upper limit and lower limit of the height data automatically.

#### <6> Full-scale display range

Specify the upper and lower limits of the height data to be displayed with 256 step gradation within the actual range of height data. In other words, specify what range of the height data is to be displayed with 256 step gradation.

To do so, drag the red (for the upper limit) and blue (for the lower limit) cursors on the frame to set the range.

#### <7> 256 step display range

Specify the upper and lower limits of the height data within the 256 step display range.

To do so, drag the red (for the upper limit) and blue (for the lower limit) cursors on the frame to set the range.

#### <8> Upper limit, center, width and lower limit

##### [Upper limit] box

Shows the upper limit value specified in the 256 step display range.

##### [Center] box

Shows the center value between the upper and lower limits of the specified range.

##### [Apply color centered on reference surface (height on)] checkbox

Select to set the center value to 0. The [Center] box will be grayed out.



Before using this setting, it is necessary to set the reference plane in the image processing window.

Reference Plane Settings (Page 5-3)

##### [Width] box

Shows the width of the range specified with the upper and lower limits.

##### [Lower limit] box

Shows the lower limit value specified in the 256 step display range.

**<9> [Auto setting] button**

Automatically optimizes the upper and lower limits of the height data to be displayed with 256 step gradation.

**<10> [Area settings] button**

Select and use the displayed [Area settings] window to specify the area of the height display.

The values between the maximum and minimum height data in the specified area are displayed with 256 step gradation.

**<11> Range of height values**

Shows the maximum and minimum values in the height value range for the measured height data.

**<12> Color palette**

Use it to select the color palette for the height image.

**<13> Status bar**

Displays the X and Y coordinates and heights at the mouse pointer when it is positioned over the image display area.

**3 Convert height data to RGB values.**

You can do this conversion by one of the following 3 methods.

**Convert by the [Auto setting] button**

Click the [Auto setting] button to display the height data whose upper and lower limits for 256 step gradation is automatically optimized. This is the recommended method.

If the [Center color around reference surface (height 0)] checkbox is selected, the upper and lower limit sizes are arranged to be equal, and the range is displayed with 256 step gradation.



The height display settings are applied to the height images on all the sheets of the selected file.

**Convert by value**

Enter numerical values in the [Upper limit], [Center], [Width] and [Lower limit] boxes to display the corresponding height data in the range specified in 256 step gradation. This method allows you to display multiple samples with the same step gradation (the same standard levels of gradation). Changing the value of [Center] while keeping [Width] constant adjusts the setting with the specified range (the range between the upper and lower limits) kept unchanged.

Changing the value of [Width] while keeping [Center] constant enables free adjustments of the specified range (the upper and lower limits).

**Setting with the cursors of the upper and lower limits**

Drag the upper limit (red) and lower limit (blue) cursors of the height data histograms to set a corresponding 256 step gradation.

**4 Click the [OK] button (<14>) in the [Set height display] dialog box.**

The [Set height display] window closes, and the display settings are applied in the height image of the main window.



Click the [Cancel] button (<15>) to close the [Set height display] dialog box without applying the settings.

## Setting the HDR Display

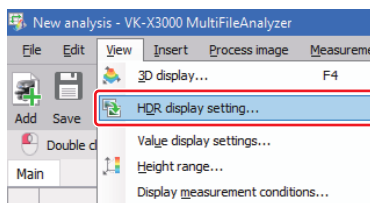
You can configure the settings for changing the brightness, etc. of the HDR images and displaying them.

### 1 Open the analysis result file or measurement data.

The grid sheet appears.

Opening/Closing File (Page 3-2)

### 2 Select [HDR display setting] from the [View] menu.

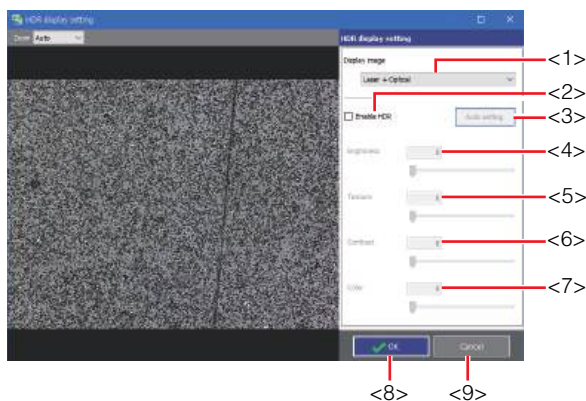


You can also open the [HDR display setting] dialog box as follows.

- Select 1 main image, and then [HDR display setting] from the right-click menu.

The [Set HDR display] window appears.

If you have selected multiple sets of measurement data, the first measurement data appears.



#### <1> [Display image] box

The selected image data are displayed in the image display area.

#### <2> [Enable HDR] checkbox

Select this checkbox to enable the HDR setting.

#### <3> [Auto setting] button

Automatically adjusts the brightness, texture, contrast, and color.

#### <4> [Brightness]

Drag the slider to adjust the image brightness.

#### <5> [Texture]

Drag the slider to enhance the fine patterns on the image surface.

#### <6> [Contrast]

Drag the slider to adjust the tone of the image contrast.

#### <7> [Color]

Drag the slider to adjust the color saturation (color intensity) of the image.

### 3 Click the [Enable HDR] checkbox (<2>).

There are two methods shown below to adjust HDR.

#### Convert by the [Auto setting] button

Enabling the [Auto setting] button (orange) adjusts the brightness, texture, contrast, and color automatically. This is the recommended method.

#### Convert by value

Enter a numeric value into the [Brightness], [Texture], [Contrast], and [Color] boxes or edit the values by dragging the respective sliders.

### 4 Click the [OK] button (<8>) in the [HDR display setting] dialog box.

The [HDR display setting] window closes, and the HDR display settings are applied in the image of the main window.

Click the [Cancel] button (<9>) to close the [HDR display setting] dialog box without applying the settings.

## Changing Measurement Units and Number of Digits

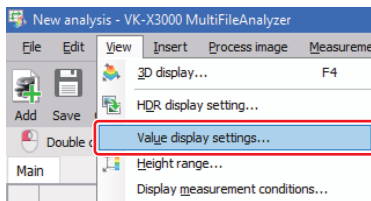
This section describes how to change the unit and number of digits after the decimal point which are shown in the measurement editing window and on the scale.

### 1 Open the analysis result file or measurement data.

The grid sheet appears.

Opening/Closing File (Page 3-2)

### 2 Select [Value display settings] from the [View] menu.



The [Value display settings] dialog box appears.

### 3 Set the display unit and the digits after the decimal point.



#### [Show thousand separator] checkbox

Select to display delimiter in numerical values.

#### All measurements

Set the value display for the measurement result.

- [Digits after the decimal point] box  
Select the number of digits after decimal point from "0", "1", "2", "3" and "4".
- [Display unit] box  
Select a display unit from "mm", "µm", and "nm".


#### Roughness measurements

Set the value display of the line roughness, multi-line roughness, and surface roughness measurement.

- [Digits after the decimal point] box  
Select the number of digits after decimal point from "0", "1", "2", "3" and "4".
- [Display unit] box  
Select a display unit from "mm", "µm", and "nm".

### 4 Click the [OK] button in the [Value display settings] dialog box.

The new units and digits are applied in the measurement editing window.

 Click the [Cancel] button to close the [Value display settings] dialog box without applying the settings.

# Displaying Measurement Conditions

The measurement conditions at the time the image was captured and saved are displayed in the [Display measurement conditions] dialog box.

This section describes the list of measurement conditions displayed in the [Display measurement conditions] dialog box and how to display them.

## List of Measurement Conditions

The following shows the list of measurement conditions and their details that are displayed when you open the [Display measurement conditions] dialog box.



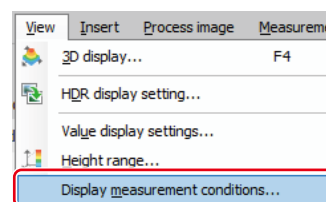
Measurement data name	Saved measurement data file name
Measured date	Measurement date - MM/DD/YY HH:MM:SS
Measurement Mode	The measurement mode used for measurement
Scan Mode	The scan mode used for observation
Resolution	The measurement area size used for measurement
Measurement Quality	The measurement quality used for measurement
Pitch	The pitch used for measurement
RPD	RPD enabled or disabled
Brightness	PMT sensitivity setting value 1 used for observation
Brightness 2	PMT sensitivity setting value 2 used for observation
ND Filter	ND filter value 1 used for observation
ND Filter 2	ND filter value 2 used for observation
Double scan	Double scan enabled or disabled
Average Measurement	Average count set in the image average
Smart HDR	Smart HDR enabled or disabled

Measurement data name	Saved measurement data file name
Optical zoom	Optical zoom magnification used for observation
Z Measurement Distance	The measurement range used for measurement
Measurement Head	Head type
Objective Lens Name	Object lens name used for observation
Objective Lens Power	Object lens zoom magnification used for observation
NA	Aperture of object lens used for observation
Field curvature correction	With or without image surface flexure correction
Eucentric correction	With or without laser intensity eccentricity correction
Ring light correction	With or without ring light correction
XY Calibration	XY calibration value
Z Calibration	Z calibration value
Light reception laser intensity correction mode	Correction mode for light reception output correction (γ correction/Free set)
Gamma Correction Value	Gamma correction value
Offset	Offset correction value
W/B inversion	Monochrome inversion enabled or disabled

## Displaying Measurement Conditions

This section describes how to open the [Display measurement conditions] dialog box and insert the measurement conditions into the measurement analysis worksheet.

- 1 Open the analysis result file or measurement data.**  
The grid sheet appears.  
Opening/Closing File (Page 3-2)
- 2 Select [Display measurement conditions] from the [View] menu.**



The [Display measurement conditions] dialog box appears.

MEMO

# Measurement Preprocessing

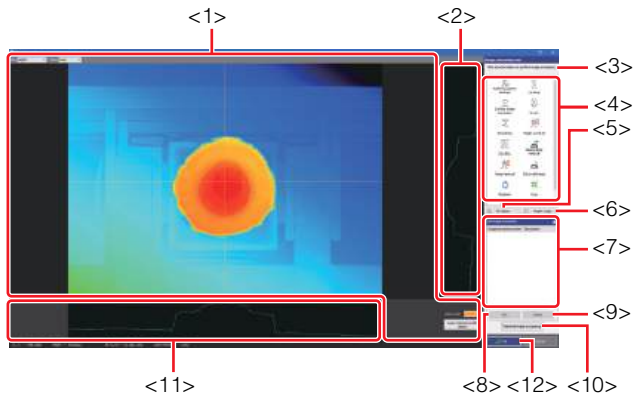
This chapter describes various functions of the [Process image] menu.

Window Used For Image Processing .....	Page 5-2
Reference Plane Settings .....	Page 5-3
Leveling .....	Page 5-9
Surface Shape Correction .....	Page 5-11
Inverting an Image .....	Page 5-16
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# Window Used For Image Processing

Select [Process image] from the [Process image] menu, or click the [Process image] button on the toolbar to display the image processing window.

The following describes the names and functions of various parts of the image processing window.



## <1> Image display area

This area displays an image of the measurement data. Horizontal and vertical cursors appear. You can move the cursors by dragging them.

For information on the [View] box, [Zoom] box and [Cursor color] palette, see [Image display area](#) (Page 5-3).

## <2> Profile graph display area

This area displays a profile graph corresponding to the vertical cursor position.

## <3> Layer

Select a layer.

	Only displayed for surface film thickness measurement data.
--	---

## <4> Image processing tool buttons

These are used to perform various types of image processing.

- [Reference Plane Settings](#) (Page 5-3)
- [Leveling](#) (Page 5-9)
- [Surface Shape Correction](#) (Page 5-11)
- [Inverting an Image](#) (Page 5-16)
- [Smoothing](#) (Page 5-17)
- [Height Cut Level](#) (Page 5-19)
- [DCL/BCL](#) (Page 5-22)
- [Missing Data Removal](#) (Page 5-25)
- [Noise Removal](#) (Page 5-26)
- [Set invalid area](#) (Page 5-28)
- [Screen rotation](#) (Page 5-29)
- [Image trimming](#) (Page 5-30)
- [C-DIC setting](#) (Page 5-32)

[Auto Position Alignment](#) (Page 5-34)

## <5> [3D display] button

Displays the [3D display] dialog box.

[Configuring Image Display](#) (Page 4-4)

## <6> [Height range] button

Click to set display of height image.

[Settings for Displaying a Height Image](#) (Page 4-9)

## <7> Image processing history

This area displays the image processing operations that have been performed on the selected image, starting with the oldest.

## <8> [Edit] button

Edits the contents of the selected image processing operation.

[Reference Plane Settings](#) (Page 5-3)

[Leveling](#) (Page 5-9)

[Surface Shape Correction](#) (Page 5-11)

[Inverting an Image](#) (Page 5-16)

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[Height Cut Level](#) (Page 5-19)

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[C-DIC setting](#) (Page 5-32)

[Auto Position Alignment](#) (Page 5-34)

## <9> [Delete] button

Click to undo the selected image processing operation.

## <10> [Delete all image processing] button

Click to undo all the image processing operations.

This restores the image to the state it was in immediately after the measurement data was added to Multifile Analyzer Software.

## <11> Profile graph display area

This area displays a profile graph corresponding to the horizontal cursor position.

## <12> [OK] button

Click to confirm and finish the image processing. The image processing history is saved.

# Reference Plane Settings

You can set a reference plane in order to use as a reference (reference plane) for measuring height data. The entire height data is rotated and offset so that the determined plane is the reference plane with the height zero (0).

Set a reference plane to be used in profile measurement, comparative measurement, plane measurement, and average step measurement (flatness).

Specifically, the reference plane is used as follows:

- For profile measurement or comparative measurement:  
A profile is found at a cross-section perpendicular to the set reference plane, and the outline of the profile is measured.
- For plane measurement:  
Measurement is performed on a 2D image viewed parallel to the set reference plane.
- For average step measurement (flatness)  
Areas are measured with the height of the reference plane assumed to be 0.

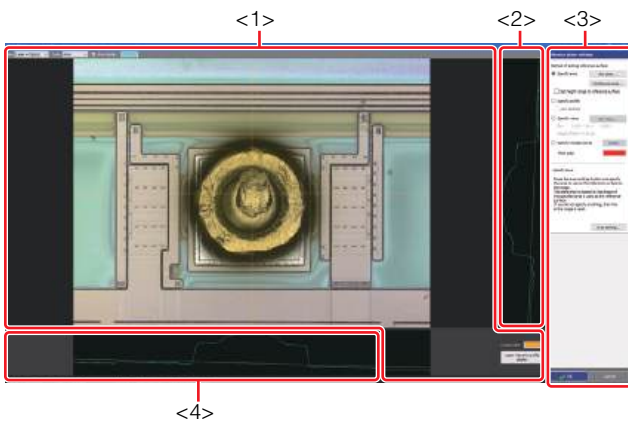


When "Any plane" is specified in the settings of reference area, the specified area on "Any plane" becomes the reference plane.

## Screen Used for Reference Plane Setting

In the image processing window, click the [Reference plane settings] button to display the [Reference plane settings] window.

The following describes the names and functions of parts of the [Reference plane settings] window.



### <1> Image display area

Displays the measurement data viewed along a direction perpendicular to the current reference plane.

### <2> Profile graph display area

This area displays a profile graph corresponding to the vertical cursor position.

### <3> Reference plane setting tools

This area is for specifying the reference plane.

A detailed explanation of the selected reference plane method can be found underneath the specified reference plane.

Reference plane setting tools (Page 5-4)

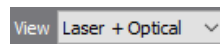
### <4> Profile graph display area

This area displays a profile graph corresponding to the horizontal cursor position.

## Image display area

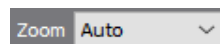
This section describes how to set the type and magnification of the image to be displayed in the image display area, and the area view, the area color and the cursor color.

[View] box



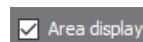
Select image type.

[Zoom] box



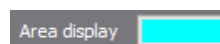
You can select a zoom level for the image.

[Area display] checkbox



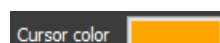
Select whether or not to use the area display.

[Area color] color palette



When [Specify area] is selected as the method of specifying the reference plane, this allows you to select a color for the set area.

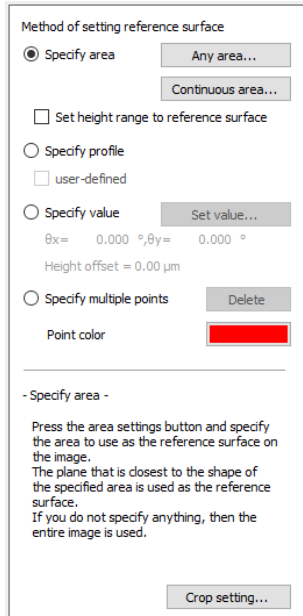
[Cursor color] color palette



Specify the color for the cursors displayed in the image display area.

## Reference plane setting tools

With the reference plane setting tools, you can click a radio button to select a method for specifying the reference plane.



### [Specify area] radio button

Select to set the reference plane from the height image with the area specified.

### [Set height range to reference surface] check box

When this is selected, the height change over the reference plane is visualized.

### [Specify profile] radio button

Select to specify the reference plane by operating the cursor on a profile.

### [Specify value] radio button

Specify the reference plane by entering a value for angle and height offset.

### [Specify multiple points] radio button

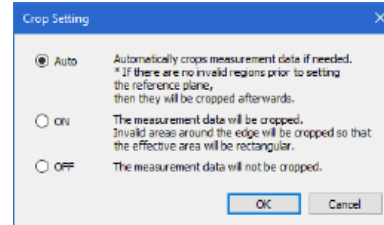
Place multiple points on an image, find a least-squares plane based on these points, and set that plane as the reference plane.

### [Point color] color palette

When [Specify multiple points] is selected as the method for specifying the reference plane, you can specify the color of the set markers.

### [Crop Setting] button

Set the crop setting to ON or OFF according to the image.



## Setting the Reference Plane by Specifying an Area

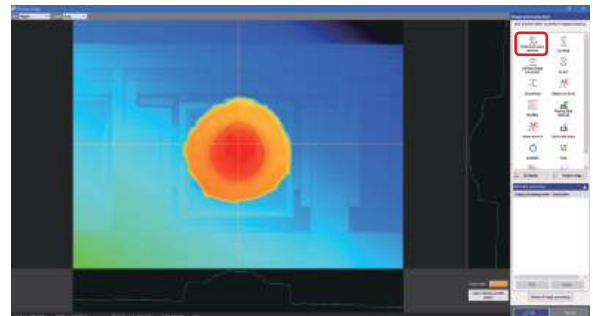
This section describes how to find a least-squares plane from the profile of a height image in a specified area, and set that plane as the reference plane.

### 1 Select the measurement data.

Opening/Closing File (Page 3-2)

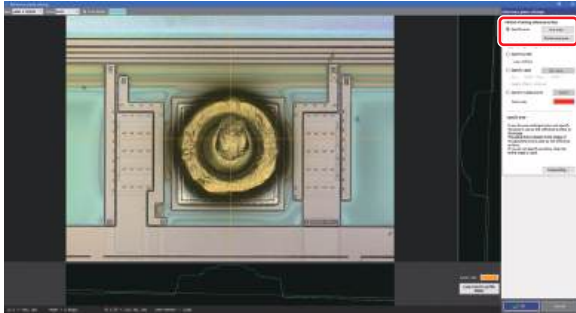
The [Process image] window appears.

### 2 Click the [Reference plane settings] button.



The [Reference plane settings] window appears.

- 3** Click the [Specify area] radio button in [Method of setting reference surface], and then click the [Any area] button or [Continuous area] button.



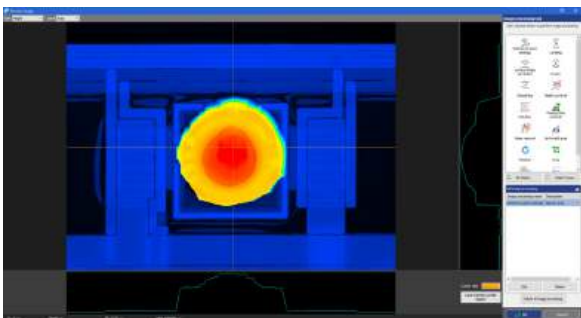
The [Area settings] window or [Extract continuous plane] window appears.

- 4** Set an area, and click the [OK] button.

- When the [Any area] button is clicked  
 Screen Used for Area Settings (Page A-2)
- When the [Continuous area] button is clicked  
 Setting an Area with Continuous Tilt (Page A-15)

- 5** Check that a reference plane has been specified, and click the [OK] button.

The [Reference plane settings] window closes, and the results of the processing are reflected in the image processing window.



## Setting the Reference Plane by Specifying a Profile

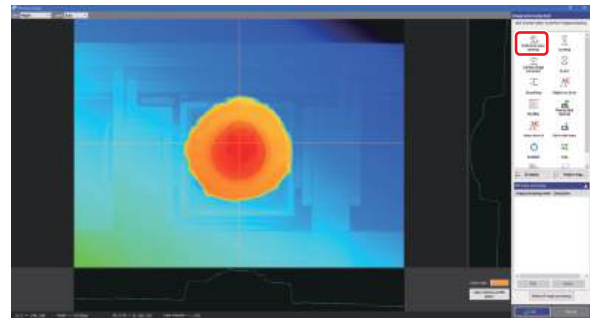
This section describes how to specify the reference plane on the profile.

- 1** Select measurement data and click the [Process image] button.

Opening/Closing File (Page 3-2)

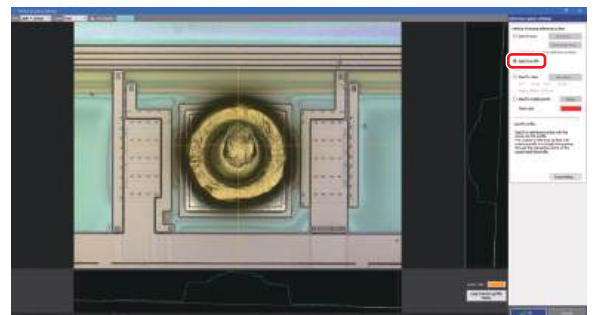
The [Process image] window appears.

- 2** Click the [Reference plane settings] button.



The [Reference plane settings] window appears.

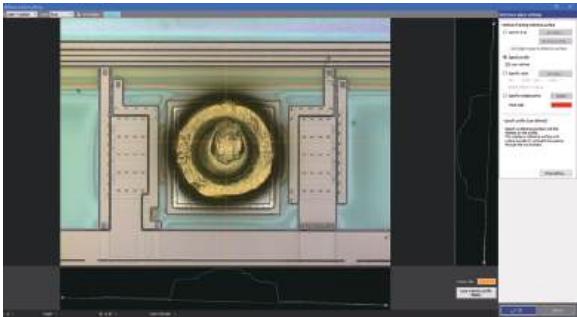
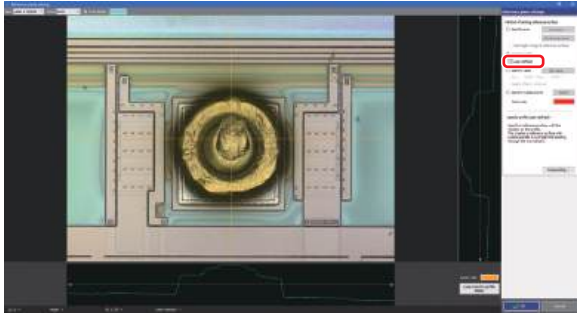
- 3** In [Method of setting reference surface], select the [Specify profile] option button.



- 4** Move the markers displayed in the profile graph display area or operate the cursor to specify the reference plane.

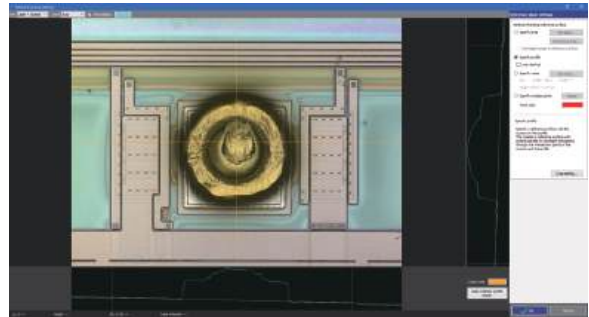
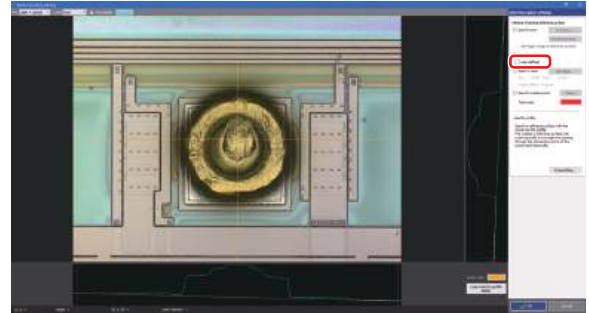
● **When the [user-defined] checkbox is selected**

Move the 2 point markers displayed in pink in the profile graph display area to specify a straight line passing between the two points.



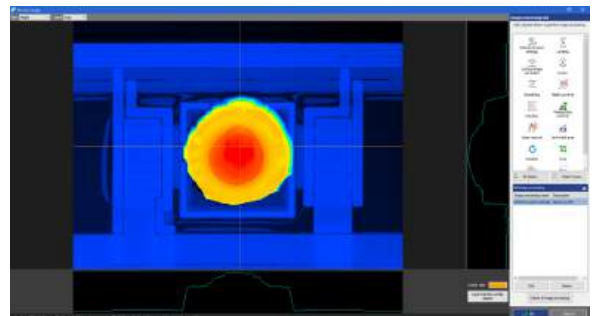
● **When the [user-defined] checkbox is cleared**

Move the 2 point markers displayed in the profile graph display area to specify a straight line passing between the two intersection points of the cursor and the profile.



**5** When the reference plane setting ends, click the [OK] button.

The [Reference plane settings] window closes, and the results of the processing are reflected in the image processing window.



## Setting the Reference Plane by Specifying Values

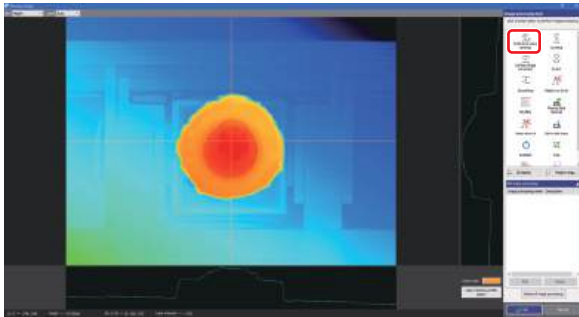
Specify the reference plane by entering a value for angle and height offset.

### 1 Select the measurement data.

Opening/Closing File (Page 3-2)

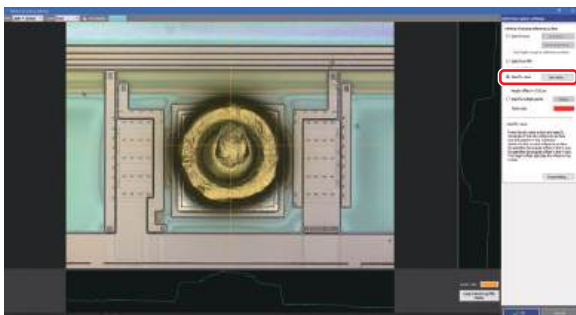
The [Process image] window appears.

### 2 Click the [Reference plane settings] button.



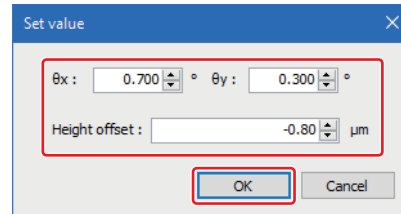
The [Reference plane settings] window appears.

### 3 Click the [Specify value] button in [Method of setting reference surface], and then click the [Set value...] button.

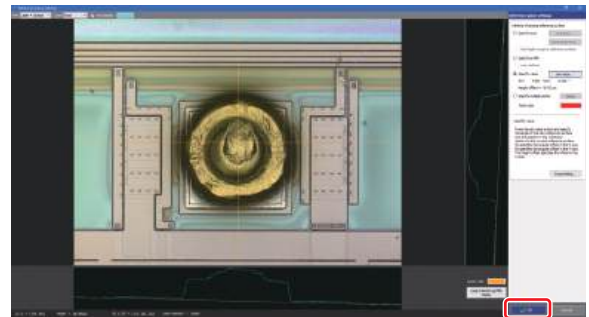


When selected, the [Set value] dialog box appears.

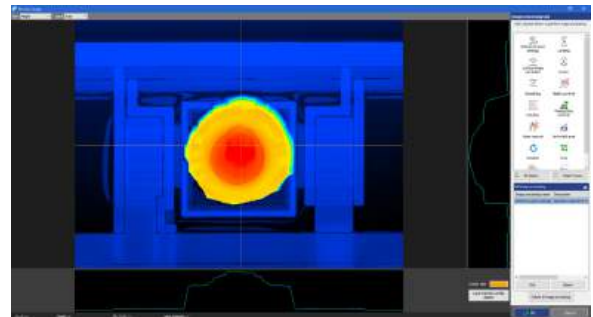
### 4 Enter the angle ( $\theta_x$ ) of the X axis, the angle ( $\theta_y$ ) of the Y axis, and the height offset, and click the [OK] button.



### 5 Check that a reference plane has been specified, and click the [OK] button.



The [Reference plane settings] window closes, and the results of the processing are reflected in the image processing window.



## Setting the Reference Plane by Specifying Multiple Points

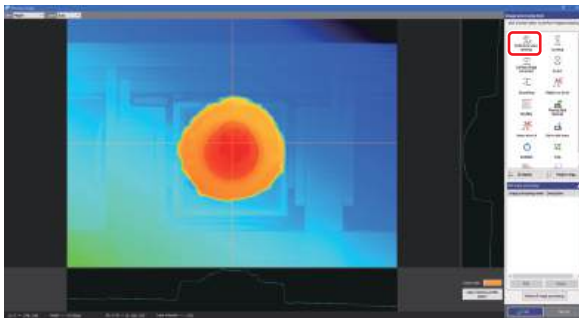
Specify multiple points on the image by conducting the least-squares plane based on these points. That plane is then set as the reference plane.

### 1 Select the measurement data.

Opening/Closing File (Page 3-2)

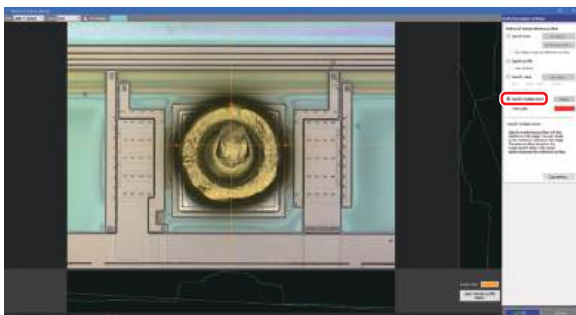
The [Process image] window appears.

### 2 Click the [Reference plane settings] button.



The [Reference plane settings] window appears.

### 3 In [Method of setting reference surface], select the [Specify multiple points] radio button.



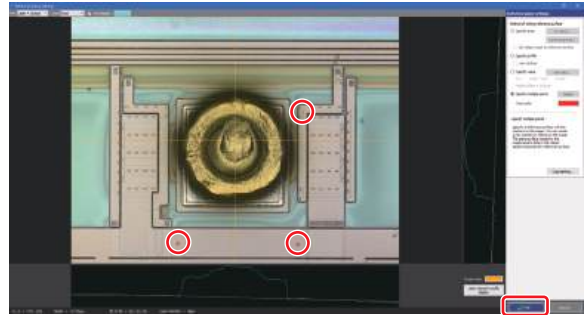
Three markers are displayed in the image display area.

### 4 Drag the markers to the desired position in the image display area.

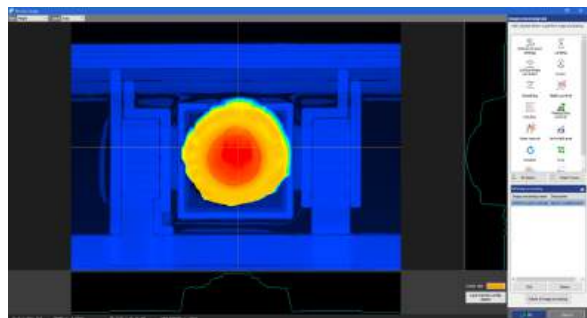


- You can click on the image display area to add markers.
- If there are four or more markers, select one of them and click the [Delete] button to delete it.

### 5 Check that a reference plane has been specified, and click the [OK] button.



The [Reference plane settings] window closes, and the results of the processing are reflected in the image processing window.



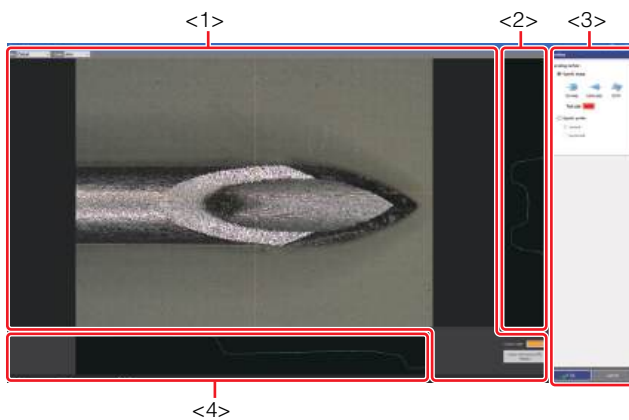
# Leveling

The leveling is the process to make the specified line or line segment horizontal. Level the shape of a surface, such as a cylinder, where the reference plane cannot be established.

## Screen Used for Area Leveling

In the image processing window, click the [Leveling] button to display the [Leveling] window.

The following describes the name and function of parts of the [Leveling] window.



### <1> Image display area

Displays the measurement data viewed along a direction perpendicular to the reference plane of the sample.

### <2> Profile graph display area

This area displays a profile graph corresponding to the vertical cursor position.

### <3> Leveling tool

Set the method for leveling.

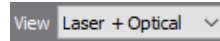
### <4> Profile graph display area

This area displays a profile graph corresponding to the horizontal cursor position.

## Image display area

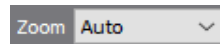
This section describes how to set the type and magnification of the image to be displayed in the image display area, and the area view, the area color and the cursor color.

### [View] box



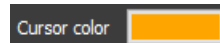
Select image type.

### [Zoom] box



You can select a zoom level for the image.

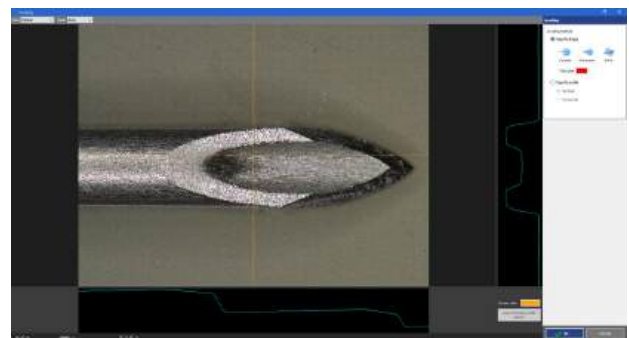
### [Cursor color] color palette



Specify the color for the cursors displayed in the image display area.

## Leveling Tool


With the leveling tools, you can click the radio buttons to select a leveling method.



### [Specify shape] radio button

You can click the [Cyl axis], [Cone axis], or [Int In] button to specify the shape to be leveled.

 [Cyl axis] button (Page A-44)

 [Cone axis] button (Page A-45)

 [Int In] button (Page A-45)

### [Specify profile] radio button

Select the profile from the [Vertical] and [Horizontal] radio buttons.

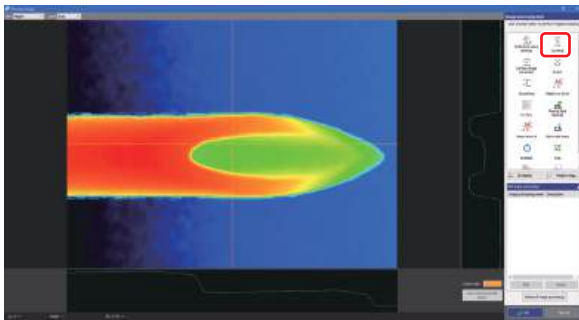
## Creating Level

### 1 Select measurement data and click the [Process image] button.

📖 Opening/Closing File (Page 3-2)

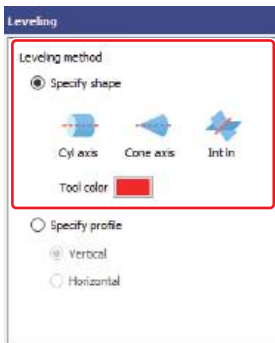
The image processing window opens.

### 2 Click the [Leveling] button.



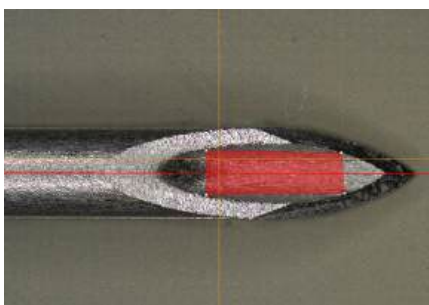
The [Leveling] window appears.

### 3 Select a leveling method using the radio buttons.



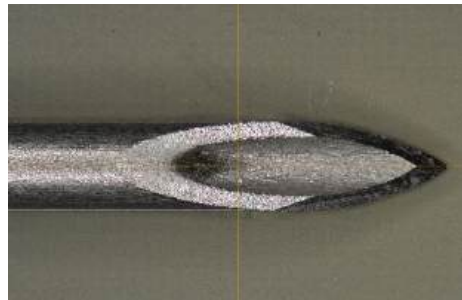
#### •Specify shape

Click the [Cyl axis], [Cone axis], or [Int In] button to specify the shape to be leveled.



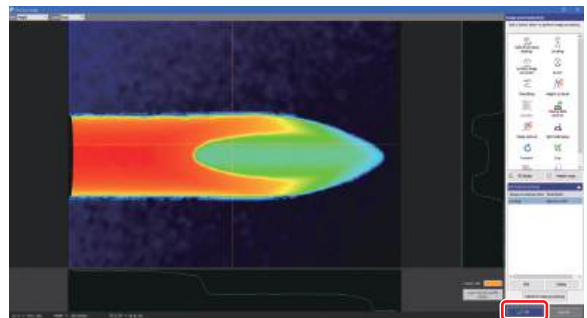
#### •Specify profile

Select the [Vertical] and [Horizontal] radio button to operate the cursor displayed within the profile graph display area to specify a straight line to be leveled.



### 4 After finishing the leveling, click the [OK] button.

The [Leveling] window closes, and the processing results are reflected in the image processing window.



# Surface Shape Correction

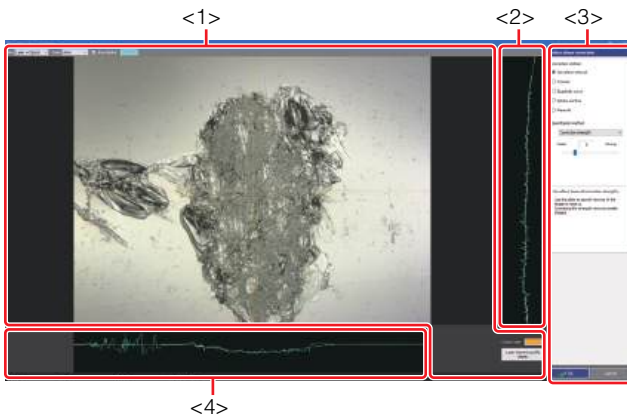
Surface shape correction is a form of processing that creates a plane by performing various types of correction processing on height data. Whether there are minute structures on a wavy surface or a surface with a large curvature, performing surface shape correction will make the minute structures easier to observe.

**Important** Surface shape correction is only applicable to height data.

## Screen Used for Surface Shape Correction

In the image processing window, click the [Surface shape correction] button to display the [Surface shape correction] window.

The following describes the name and function of components of the [Surface shape correction] window.



### <1> Image display area

Displays the measurement data viewed along a direction perpendicular to the reference plane of the sample.

### <2> Profile graph display area

This area displays a profile graph corresponding to the vertical cursor position.

### <3> Surface shape correction tools

This area is for setting the method of correction.

When a correction method is selected, an explanation of the selected method is displayed in text format in the area under Correction method.

Surface Shape Correction Tools (Page 5-12)

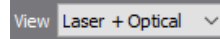
### <4> Profile graph display area

This area displays a profile graph corresponding to the horizontal cursor position.

## Image display area

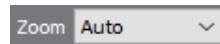
This section describes how to set the type and magnification of the image to be displayed in the image display area, and the area view, the area color and the cursor color.

### [View] box



Select image type.

### [Zoom] box



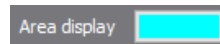
You can select a zoom level for the image.

### [Area display] checkbox



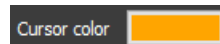
Select whether or not to use the area display.

### [Area color] color palette



Specify the color for the set area when [Quadratic curve (Specify area)] or [Sphere surface (Specify area)] is selected for the correction method.

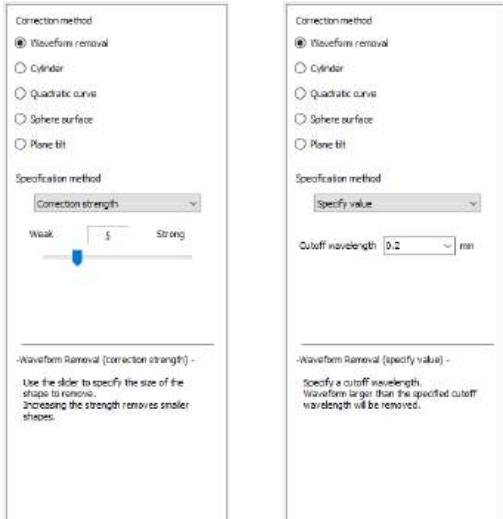
### [Cursor color] color palette



Specify the color for the cursors displayed in the image display area.

## Surface Shape Correction Tools

With the surface shape correction tools, you can click the radio buttons to select a surface shape correction method.



### [Waveform removal (Correction strength)] radio button

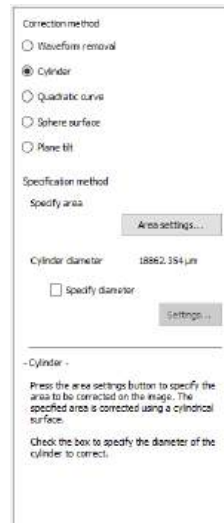
Remove a waveform from the shape of the height image in the specified area, and correct to a horizontal plane.

You can use the slider to specify the strength of the waveform removal.

### [Waveform removal (Specify value)] radio button

Remove a waveform larger than the specified length, and correct to a horizontal plane.

Enter a value and set the wavelength (length) to remove.



### [Cylinder correction] radio button

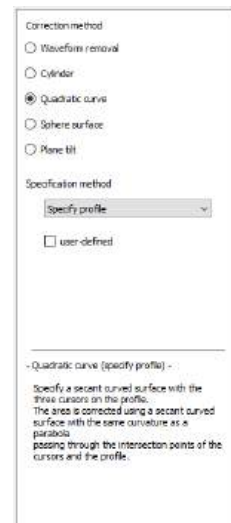
Remove a shape of the cylinder included in the height image, and correct it to a horizontal plane.

Specify the area of the cylinder from the image display area. You can also set the diameter of the cylinder by entering a value.



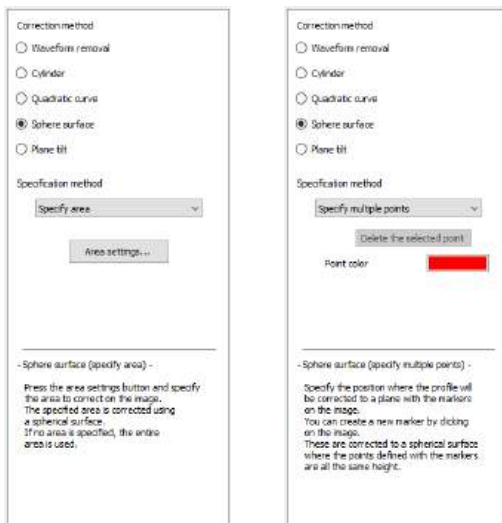
### [Quadratic curve (Specify area)] radio button

A secondary curved surface is estimated from shape of the height image set for the area, and corrected to a horizontal plane.



### [Quadratic curve (Specify profile)] radio button

Move the cursor on a profile to determine a secondary curved surface, and correct to a horizontal plane.



#### [Sphere surface (Specify area)] radio button

A spherical surface is estimated from the shape of the height image set for the area, and corrected to a horizontal plane.

#### [Sphere surface (Specify multiple points)] radio button

A spherical surface is estimated from multiple points placed on the image, and the surface is corrected to a horizontal plane.



#### [Plane tilt (Specify area)] radio button

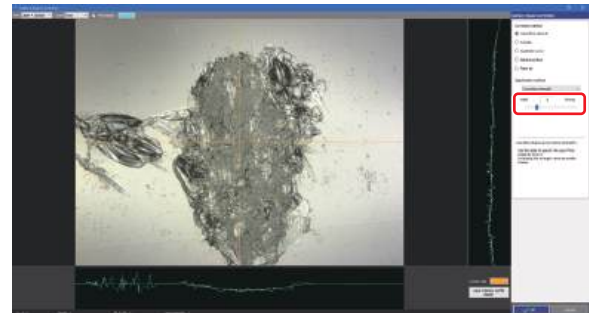
An entire plane tilt is obtained from the height image set for the area using the least squares method, and the surface is corrected to a horizontal plane.

## Surface Shape Correction Method

### ● Waveform removal (Correction strength)

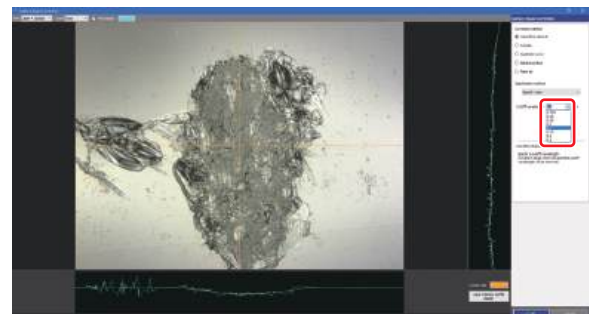
Use the slider to specify the strength of the waveform removal.

Increasing the waveform removal strength will result in smaller waveforms being removed.



### ● Waveform removal (Specify value)

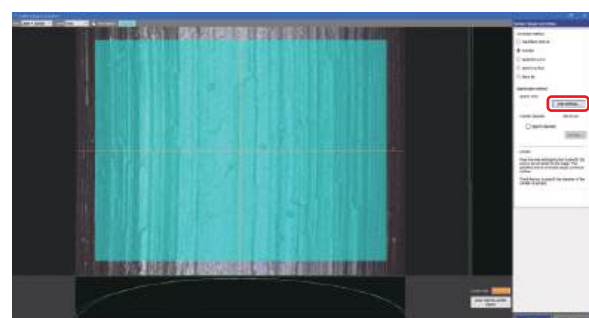
Select the cutoff wavelength from the pull-down list, and specify the strength of the waveform removal.



### ● Cylinder (Area settings)

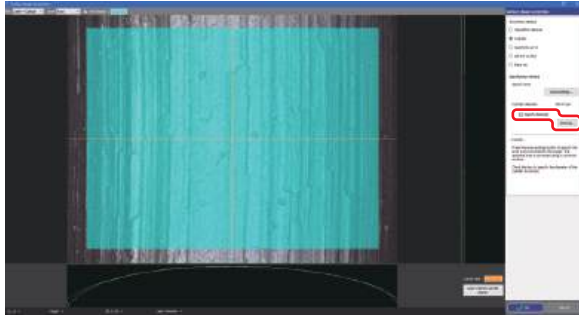
Click the [Area settings] button and set an area to be a cylinder.

A cylindrical surface is estimated from the height image set as an area, and the surface shape is corrected.



● **Cylinder (Specify value)**

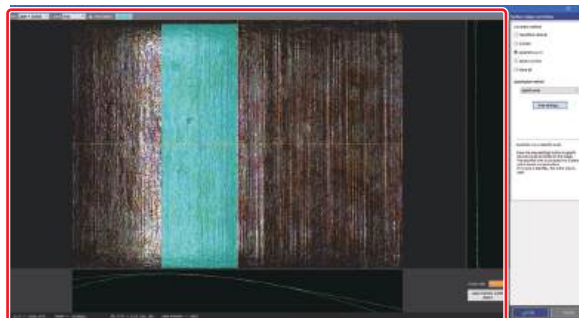
Select the [Specify diameter] checkbox and click the [Settings] button to enter a diameter. A cylindrical surface is estimated from the height image set as an area, and the surface shape is corrected.



● **Sec curved surf. (Specify area)**

Click the [Area settings] button and set an area. A secondary curved surface is estimated from the height image set for the area, and surface correction is performed.

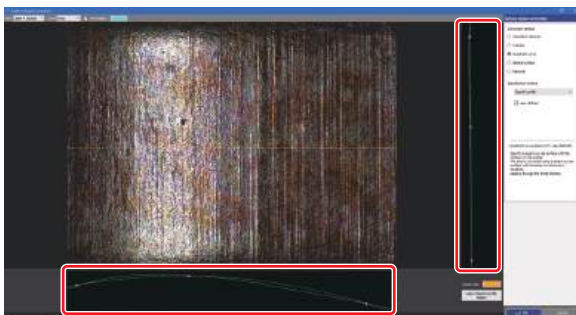
📖 Area Settings (Page A-2)



● **Quadratic curve (Specify profile)**

When the [user-defined] checkbox is selected

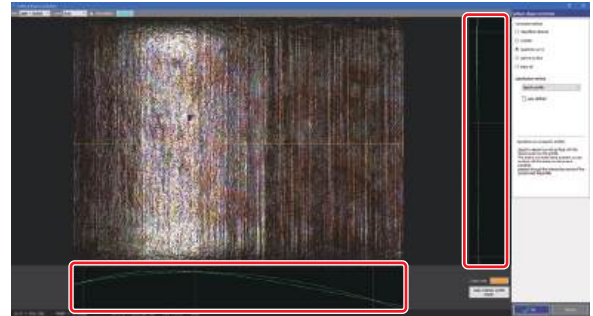
Three points (●) for correcting the surface shape are displayed in the profile graph display area. Drag the above points into the target positions to correct the surface shape based on the slope of a parabola passing through the points.



When the [user-defined] checkbox is not selected

Three cursors for surface shape correction are displayed in the profile graph display area.

Drag the above cursors into the target positions to correct the surface shape based on a parabola passing through the intersections of the cursors and the profile graph.



● **Sphere surface (Specify area)**

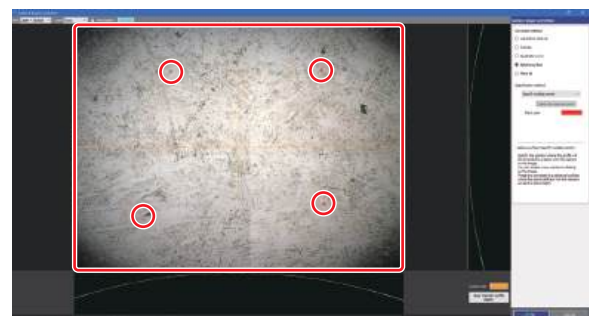
Click the [Area settings] button and set an area. A sphere surface is estimated from the height image set as an area, and the surface shape is corrected.

📖 Area Settings (Page A-2)



● **Sphere surface (Specify multiple points)**

Four points (●) for surface shape correction are displayed in the image display area. In the image display area, drag these points into the target positions. A sphere surface is estimated from the height image for the point positions, and the surface shape is corrected.





**If the radius of the sphere is too small to permit capture of the entire image, an error will occur.**

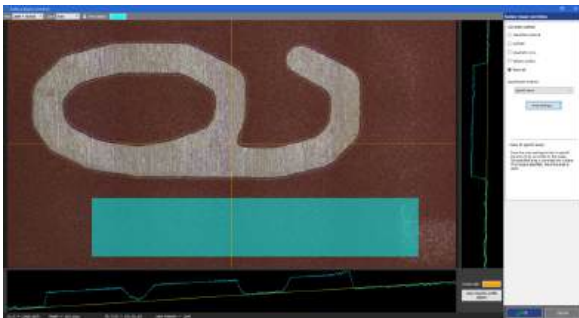


- Click the image display area to add a point.
- If there are 5 or more points, select one of them and click the [Delete the selected point] button to delete it.

### ● Plane tilt (Specify area)

Click the [Area settings] button and set an area. A plane tilt is estimated from the height image set as an area, and the surface shape is corrected.

Area Settings (Page A-2)



## Surface Shape Correction Algorithms

### ■ Waveform removal

With waveform removal, complex waveforms in the surface are removed by applying a band-pass filter on the height data in the area.

You can adjust the filter frequency by adjusting the slider (slide bar) right and left, or selecting the cutoff frequency.

### ■ Cylinder correction

With cylinder correction, calculation and correction based on the height data in the area are performed so that a cylinder estimated using the least squares method becomes a horizontal plane.

If specifying an arbitrary diameter, calculation and correction are performed so that a cylinder with the diameter where the axis based on the area of the cylinder is specified as the center becomes a horizontal plane.

### ■ Secondary curved surface correction (specify area)

With secondary curved surface correction (specify area), a curved line ( $z=ax^2+by^2+cx+dy+exy+f$ ) undergoes correction until it is flat.

With secondary curved surface correction (specify area), a, b, c, d, e and f are calculated by solving the above equation based on the height data of entire area or the specified area.

### ■ Secondary curved surface correction (specify profile)

With secondary curved surface correction (specify profile) a first curve is defined as:

$$(z=ax^2+cx+f)$$

that connects 3 points set on the profile graph with the horizontal cursor and a second curve is defined as :

$$(z=by^2+dy+exy+f)$$

that connects 3 points set on the profile graph with the vertical cursor are calculated and corrected until they become flat.

### ■ Sphere surface correction (specify area)

With sphere surface correction (specify area), calculation and correction based on the height data in the area are performed so that a sphere estimated using the least squares method becomes a horizontal plane.

### ■ Sphere surface correction (specify multiple points)

With sphere surface correction (specify multiple points) calculation and correction are performed based on the specified multiple points so that a sphere estimated using the least squares method becomes a horizontal plane.

### ■ Plane tilt (Set area)

With Plane tilt (Set area), a, b and c values on the plane of  $z=ax+by+c$  are calculated respectively by solving the system of equations.

With Plane tilt (Set area), a, b and c values are calculated respectively by solving the above equation using the least squares method based on the height data of entire area or the specified area.

By using the above a, b and c values, obtain the heights of 4 corners (0,0), (1023,0), (1023,767) and (0,767) of the image, and record the minimum value.

Using the above equation, heights are calculated on the entire data on the image. Then, the tilt is corrected by subtracting the difference between those values and minimum value from the actual height data.

# Inverting an Image

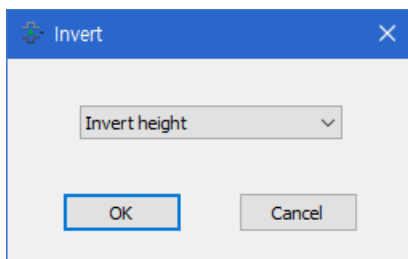
The image is inverted.

When a replica of a sample is made the measured data should be inverted in order to reflect the measurements of the real sample.

## Window Used For Inverting an Image

Click the [Invert] button in the image processing window to display the [Invert] dialog box.

The following describes the name and function of the [Invert] dialog box.



[Invert] box

- Invert height  
Inverts the height of an image.
- Flip horizontal  
Inverts right and left of an image.
- Flip vertical  
Inverts top and bottom of an image.
- Laser Inversion  
Inverts the laser intensity of the image.

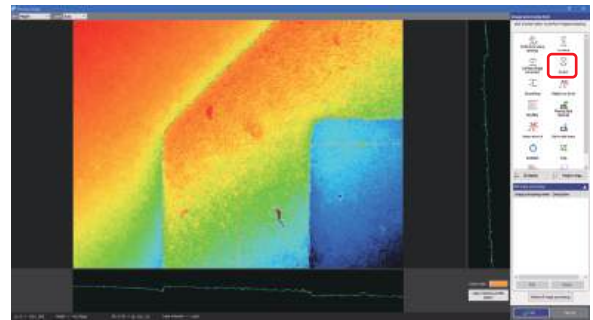
## Inverting Image

- 1 Select measurement data and click the [Process image] button.**

Opening/Closing File (Page 3-2)

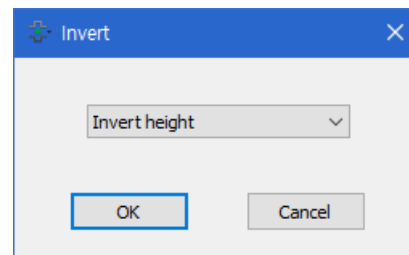
The image processing window opens.

- 2 Click the [Invert] button.**



The [Invert] dialog box appears.

- 3 Select the type of invert processing, and click the [OK] button.**



5

Measurement Preprocessing

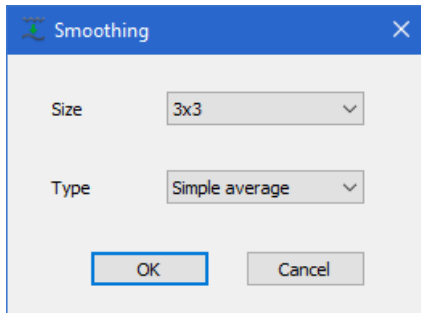
# Smoothing

This section describes how to eliminate speckling noise or other discrepancies using the smoothing filter.

## Screen Used for Smoothing Filter

In the image processing window, click the [Smoothing] button to display the [Smoothing] dialog box.

The following describes the name and function of parts the [Smoothing] dialog box.



### [Size] box

Selects the unit (number of vertical and horizontal pixels) for the filter processing.

- 3x3

A value for the center pixel of 3x3 is calculated from the values of the pixels above/below and left/right, and the current value of the center pixel is replaced with calculated value.

- 5x5

A value for the center pixel of 5x5 is calculated from the values of the pixels above/below and left/right, and the current value of the center pixel is replaced with calculated value.

- 7x7

A value for the center pixel of 7x7 is calculated from the values of the pixels above/below and left/right, and the current value of the center pixel is replaced with calculated value.

### [Type] box

Selects the filter type.

- Simple average

Eliminates noise from noisy images by averaging the density of the pixels in a specific area.

Use this button to smooth the entire image.

- Gaussian

This is a Gaussian variation of weighted averaging.

Use this button to average the entire image while retaining the image features.

- Median

Eliminates noise while preventing blurred edges, by providing median values of pixels in a specific area.

Use this button to eliminate speckling noise.

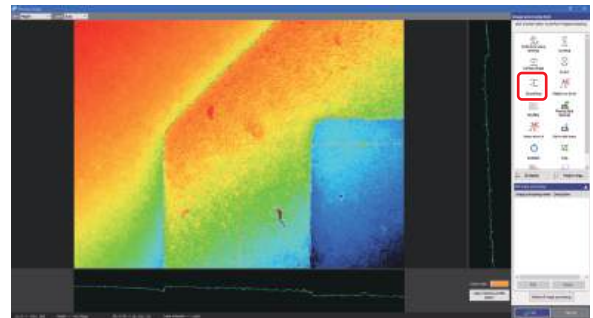
## Applying the Smoothing Filter

- 1 Select measurement data and click the [Process image] button.

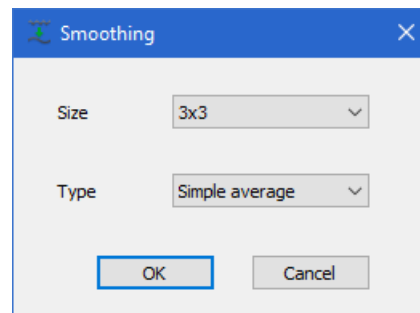
Opening/Closing File (Page 3-2)

The image processing window opens.

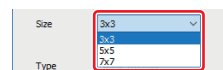
- 2 Click the [Smoothing] button.



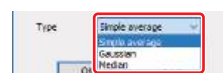
The [Smoothing] dialog box appears.



- 3 Select the unit (number of vertical and horizontal pixels) for the filter processing in the [Size] box.

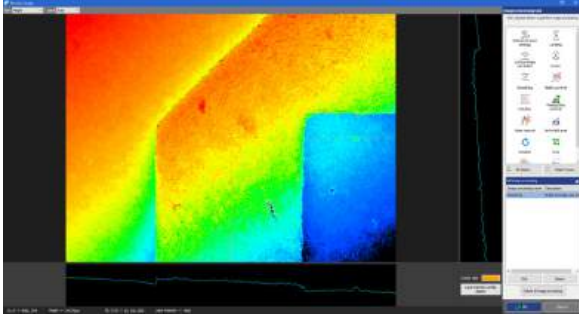


- 4 Use the [Type] box to select a filter type.



**5** Click the [OK] button.

The results of the filter processing are reflected in the image display area.



5

Measurement Preprocessing

# Height Cut Level

If a part of the image data is indicating an abnormal value (too low or too high), eliminate the noise in the height direction by setting a cut level.

Noise removal is performed by interpolating data either from adjacent pixels or area data.

▶ Important

**When the region of interest (ROI) is set, the interpolation is only applied to the ROI.**

## Screen Used for Cutting in Height Direction

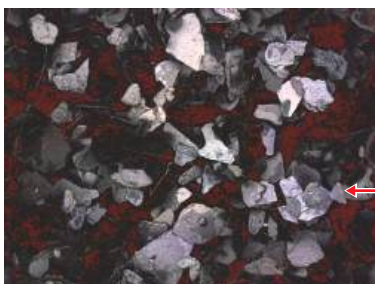
In the image processing window, click the [Height cut level] button to display the [Height cut level] window.

The following describes the name and function of parts of the [Height cut level] window.



### <1> Image display area

Displays the main image of the image display window.



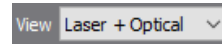
### <2> Height cut level tool

This tool bar includes buttons to configure the laser intensity cut level.

## Image display area

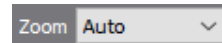
This section describes how to set the type and magnification of the image to be displayed in the image display area, and the area view, and the area color.

[View] box



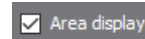
Select image type.

[Zoom] box



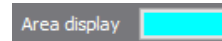
You can select a zoom level for the image.

[Area display] checkbox



Select whether or not to use the area display.

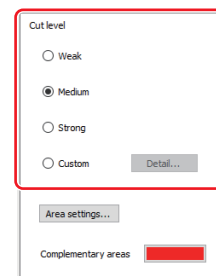
[Area color] color palette



Sets the color of the area identified as noise.

## Height cut level tool

With the height cut level tool, you can click the radio buttons to select a cut level processing method. You can also specify the area to which the height cut level is applied.



[Cut level] radio button

Selects the strength of noise removal.

### [Weak] radio button

Lowers the intensity threshold value, limiting the interpolation area.

### [Medium] radio button

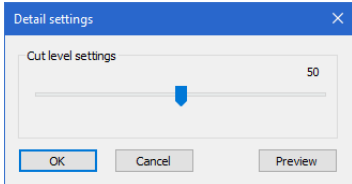
It is the standard cut level.

### [Strong] radio button

Raises the intensity threshold value, expanding the interpolation area.

**[Custom] radio button**

Click the [Detail] button to display the following [Detail settings] dialog box. Sets the height threshold value within a range of 0 to 100.



**[Cut level setting] slider**

Sets the cut level threshold value within a range of 0 to 100.

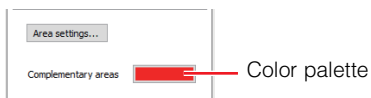
**[Preview] button**

Click this button to check the height cut level processing result in the [Height cut level] window.

**[Area settings] button**

Specifies the area to which the height cut level is applied.

For further information on the area setting procedures, refer to Area Settings (Page A-2).



**[Complementary areas] palette**

Clicking this button displays the [Color Setting] dialog box. Select a new color in the [Color Setting] dialog box.

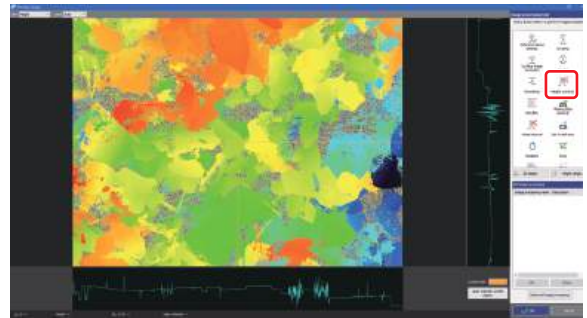
**Cutting Noise in Height Direction**

**1 Select measurement data and click the [Process image] button.**

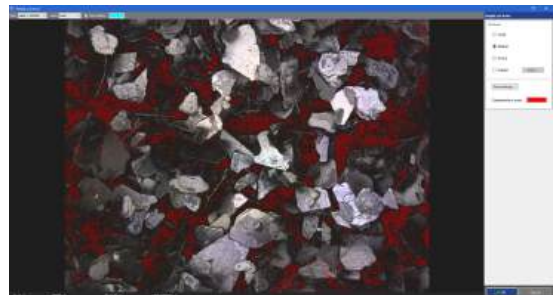
Opening/Closing File (Page 3-2)

The image processing window opens.

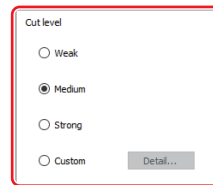
**2 Click the [Height cut level] button.**




The [Height cut level] window appears.



**3 Use the [Cut level] radio button to select the strength of noise removal.**



#### 4 Where required, click the [Area settings] button to set the area.

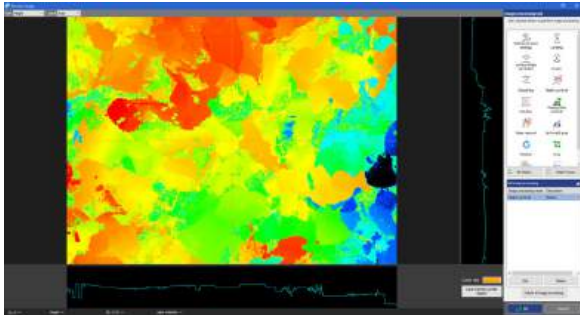
 Area Settings (Page A-2)

You can change the display color of the interpolation area using the [Complementary areas] color palette.



#### 5 Click the [OK] button.

The processing results are reflected in the image processing window.



# DCL/BCL

5

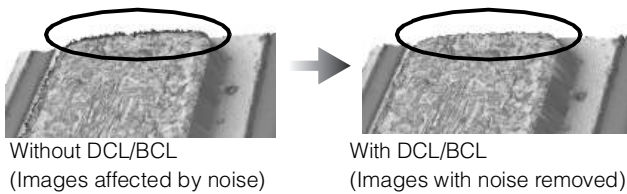
Measurement Preprocessing

The height data in areas where the reflected laser intensity is low may be affected by extraneous light and noise, making them less reliable.

DCL (Dark Cut Level) sets the cut level (lower threshold) for such data and cuts laser intensity data that are below the threshold.

Conversely, the height data in areas where the reflected laser intensity is saturated are unreliable because the focal point cannot be accurately detected.

BCL (Bright Cut Level) sets the cut level (upper threshold) for such data and cuts laser intensity data that exceed the threshold.



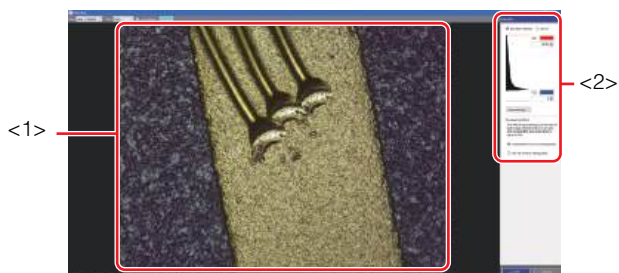
▶ Important

**When the region of interest (ROI) is set, DCL/BCL is only performed on the ROI.**

## Screen Used for DCL/BCL Setting

In the image processing window, click the [DCL/BCL] button to display the [DCL/BCL] window.

The following describes the name and function of parts of the [DCL/BCL] window.



### <1> Image display area

Displays the main image of the image display window.

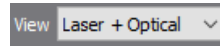
### <2> DCL/BCL tools

Contains tools for setting the laser intensity histogram and cut level for the images.

## Image display area

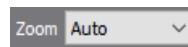
This section describes how to set the type and magnification of the image to be displayed in the image display area, and the area view, and the area color.

### [View] box



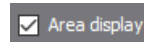
Select image type.

### [Zoom] box



You can select a zoom level for the image.

### [Area display] checkbox



Select whether or not to use the area display.

### [Area color] color palette

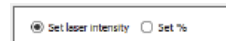


Sets the color of the cut area.

## DCL/BCL tools

With the DCL/BCL tools, you can click a radio button to select a method for specifying the cut level.

### [Set laser intensity] or [Set %] radio button



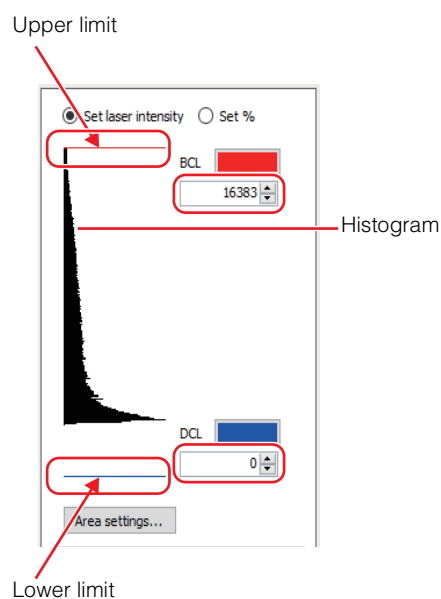
#### [Set laser intensity] radio button

The values in the [BCL] and [DCL] boxes are displayed in laser intensity values; and you can set the cut level in laser intensity values.

#### [Set %] radio button

The values in the [BCL] and [DCL] boxes are displayed in values between 0 and 100%, and you can set the cut level in percentage values.

## [BCL] box and [DCL] box



Enter the BCL and DCL values to set the threshold.

The threshold can also be set by dragging the threshold cursor in the histogram.

### [BCL] box

Enter the BCL value (laser intensity level). The laser intensity data higher than the input value will be cut (bright part).

Input range: (BCL value) to 65535

### [DCL] box

Enter the DCL value (laser intensity level). The laser intensity data below the input value (i.e. dark areas) will be cut.

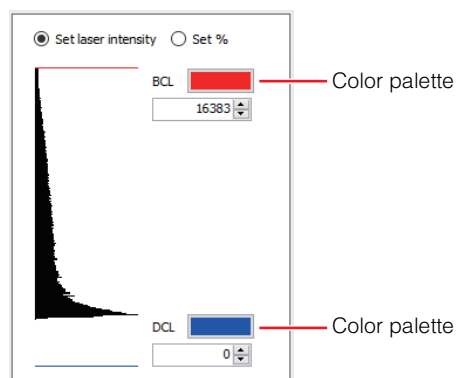
Input range: 0 to (DCL value)



The BCL and DCL input ranges are 0 to 16383 for VK-9700/8700 Series image files (\*.vk3), VK-9500 Series image files (\*.s0b, \*.s0f, and \*.s0p), and VK-8500 Series image files (\*.vk1). This is because older VK models had a PMT detector with lower resolution.

## ● Display color setting for upper/lower limit cursors

You can change the color of the upper and lower limit cursors using the color palette.



Click the [Cursor color] color palette to display the [Color Setting] dialog box, and select a new color.

### [Area settings] button

Specifies the area to which the height cut level is applied.

For further information on the area setting procedures, refer to Area Settings (Page A-2).

### Processing method

#### [Interpolate from surrounding pixels] radio button

Smoothly interpolates the gap between the data to be cut in DCL and BCL and adjacent valid data.

#### [Set the area as missing data] radio button

Sets the height of the data cut in DCL and BCL to the lowest point of the entire screen.

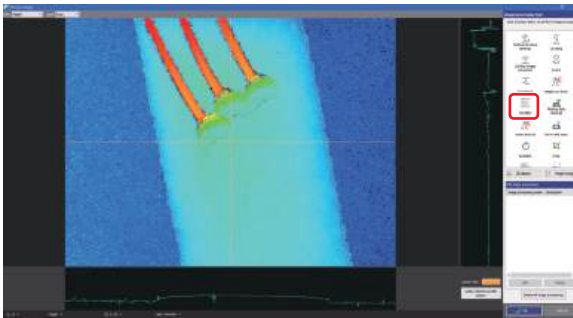
## Setting the DCL/BCL

- 1 Select measurement data and click the [Process image] button.

Opening/Closing File (Page 3-2)

The image processing window opens.

- 2 Click the [DCL/BCL] button.

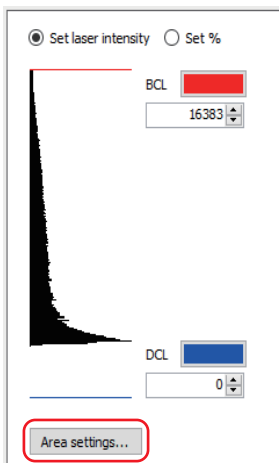


The [DCL/BCL] window appears.



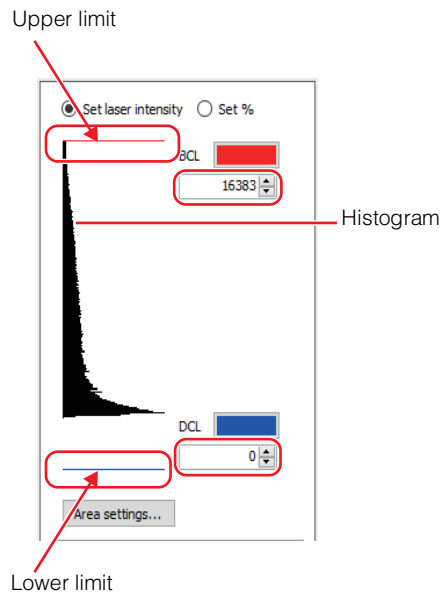
- 3 Where required, click the [Area settings] button to set the area.

Area Settings (Page A-2)

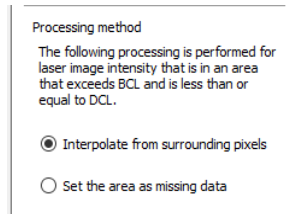


- 4 Click the [Set laser intensity] or [Set %] radio button and set the cut level unit.

- 5 Enter the BCL and DCL values into the [BCL] and [DCL] boxes, or drag the cursor on the histogram to set the thresholds.

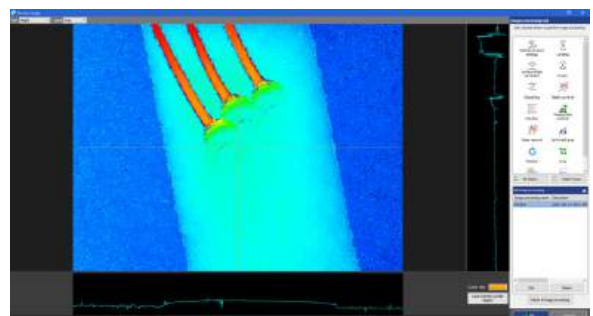


- 6 Use the [Processing method] radio button to select the noise removal processing method.



- 7 Click the [OK] button.

The processing results are reflected in the image processing window.

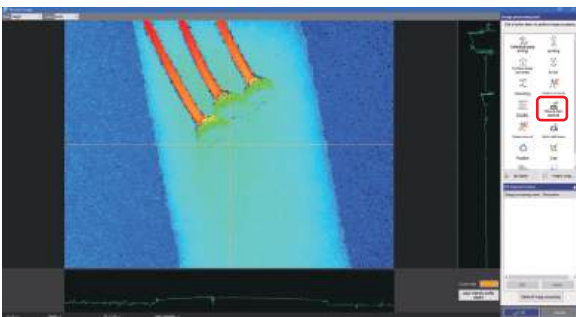


# Missing Data Removal

If any height data cannot be obtained, the tool judges those areas as missing data which will be removed. Missing data will be replaced by interpolating height data from adjacent pixels.

## Screen Used for Missing Data Removal

In the image processing window, click the [Missing data removal] button to interpolate the missing data.



▶ Important

- **Missing data removal is performed on the height image.**
- **It has no effect on invalid points.**

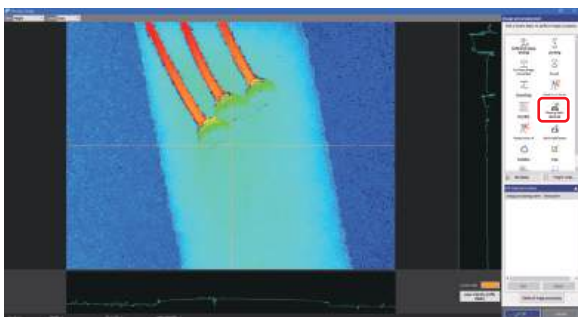
## Removing Missing Data

- 1 Select measurement data and click the [Process image] button.**

📖 Opening/Closing File (Page 3-2)

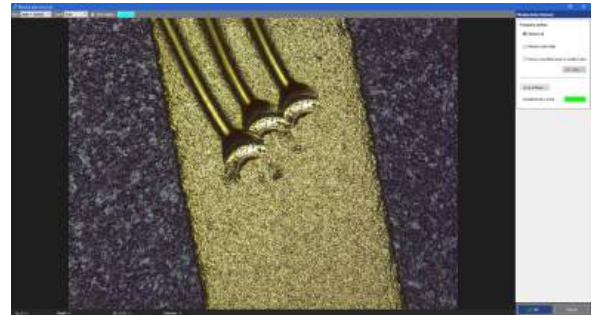
The image processing window opens.

- 2 Click the [Missing data removal] button.**



The [Missing data removal] window appears.

- 3 Select the method to process the missing point.**



### [Remove all]

The missing point removal is performed by interpolating data either from adjacent pixels or area data.

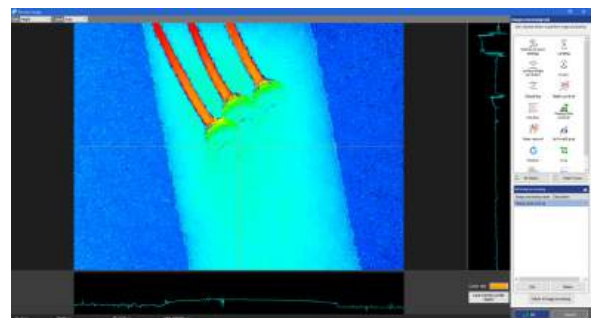
### [Remove only holes]

Remove missing points only surrounded by valid points.

### [Remove specified areas or smaller holes]

Remove specific areas and mark as missing, or specify the maximum area to be processed. This is useful for small holes.

The processing results are reflected in the image processing window.



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Measurement Preprocessing

# Noise Removal

If any data in the image has abnormal height relative to surrounding data, it's judged as noise and removed. Noisy data will be replaced by interpolating height data from adjacent pixels.

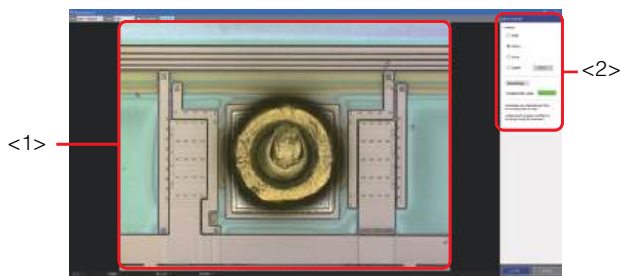
## Screen Used for Noise Removal

In the image processing window, click the [Noise removal] button to display the [Noise removal] window.

The following describes the name and function of parts of the [Noise removal] window.

5

Measurement Preprocessing



<1> Image display area

<2> Noise removal tool

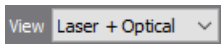
Set how to remove noise.

Noise removal tool (Page 5-26)

## Image display area

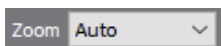
The type of image displayed and magnification level can be adjusted.

[View] box



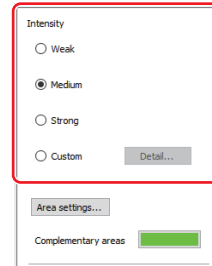
Select image type.

[Zoom] box



You can select a zoom level for the image.

## Noise removal tool



[Intensity] radio button

Selects the strength of noise removal.

**[Weak] radio button**

Lowers the intensity threshold value, limiting the interpolation area.

**[Medium] radio button**

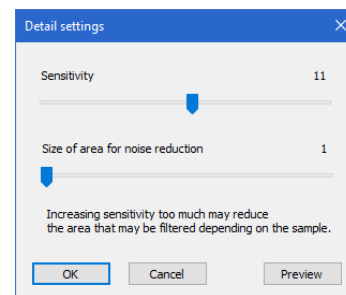
It is the standard intensity.

**[Strong] radio button**

Raises the intensity threshold value, expanding the interpolation area.

**[Custom] radio button**

Click the [Detail] button to display the [Detail settings] dialog box. After setting up, click the [OK] button to close the dialog box.



**[Sensitivity] slider**

Sets the sensitivity for noise within a range of 1 to 20.

**[Size of area for noise reduction] slider**

Sets the size for noise within a range of 1 to 20.

**[Preview] button**

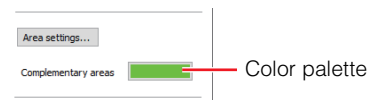
Click this button to check the processing result in the [Noise removal] window.

## Area Settings

You can change the display color of the interpolation area using the [Complementary areas] color palette.

### [Area settings] button

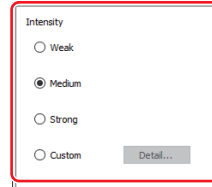
Specifies the area to which the noise removal is applied.  
For further information on the area setting procedures, refer to Area Settings (Page A-2).



### [Complementary areas] palette

Clicking this button displays the [Color Setting] dialog box. Select a new color in the [Color Setting] dialog box.

### 3 Use the [Intensity] radio button to select the strength of noise removal.



### 4 Where required, click the [Area settings] button to set the area.



### 5 Click the [OK] button.

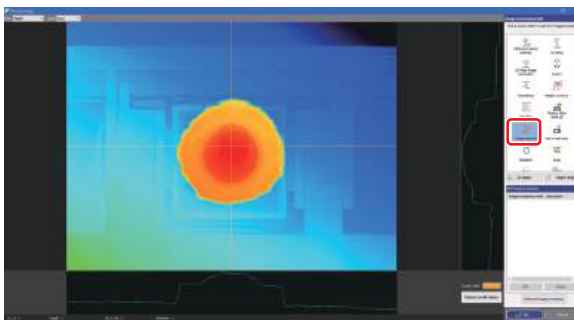
The [Noise removal] window closes, and the processing results are reflected in the image processing window.

## Removing Noise

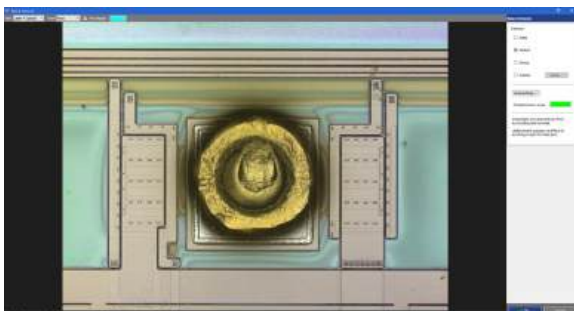
### 1 Select measurement data and click the [Process image] button.

Opening/Closing File (Page 3-2)  
The image processing window opens.

### 2 Click the [Noise removal] button.



The [Noise removal] window appears.



# Set invalid area

Sets the specified area as invalid area.

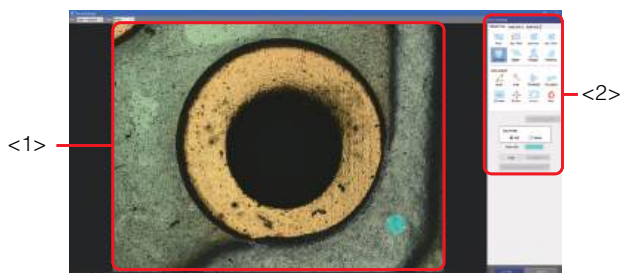
## Screen Used for Missing Data Setting

In the image processing window, click the [Set invalid area] button to display the [Set invalid area] window.

The following describes the name and functions of each part of the [Set invalid area] window.

5

Measurement Preprocessing



<1> Image display area

<2> Area setting tool

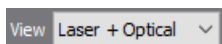
Allows an area to be set as invalid.

☰ Area Settings (Page A-2)

### Image display area

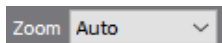
The type of image displayed and magnification level can be adjusted.

[View] box



Select image type.

[Zoom] box



You can select a zoom level for the image.

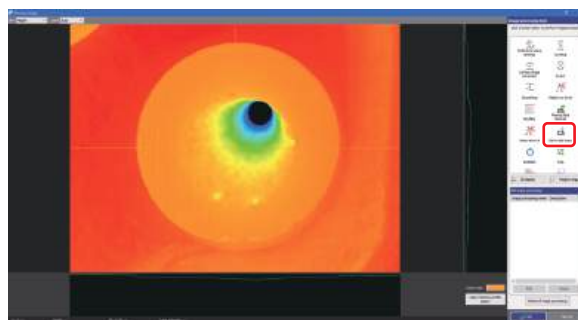
## Setting Missing Point

**1** Select measurement data and click the [Process image] button.

☰ Opening/Closing File (Page 3-2)

The image processing window opens.

**2** Click the [Set invalid area] button.

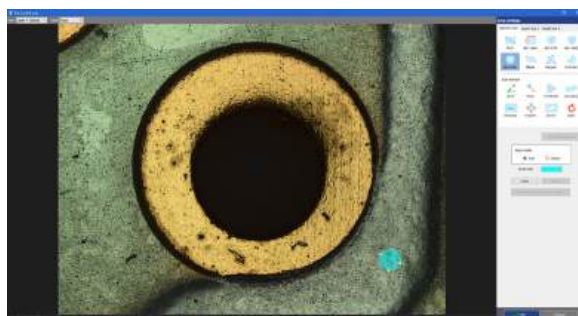


The [Set invalid area] window appears.

**3** Disable the area.

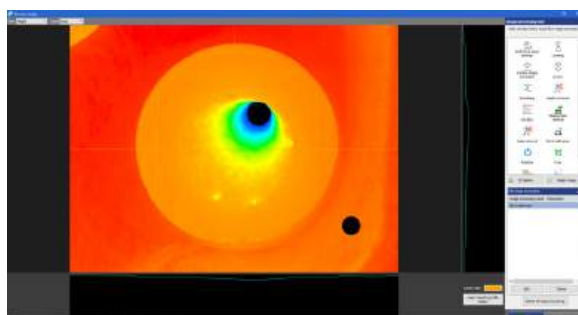
☰ Area Settings (Page A-2)

The specified area becomes the missing point.



**4** Click the [OK] button.

The processing results are reflected in the image processing window.



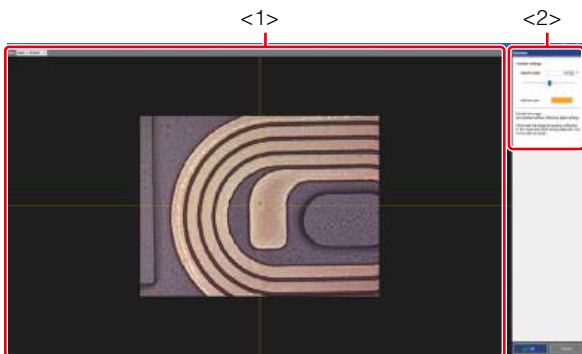
# Screen rotation

The image may be rotated by any angle.

## Window Used For Image Rotation

In the image processing window, click the [Rotation] button to display the [Rotation] window.

The following describes the name and function of parts of the [Rotation] window.



### <1> Image display area

Displays the measurement data viewed along a direction perpendicular to the reference plane of the sample.

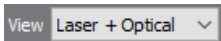
### <2> Rotation tool

Sets the image rotation.

## Image display area

The type of image displayed can be adjusted.

[View] box



Select image type.

## Rotation tool

[Specify angle]

Sets the rotation angle within a range of -180 to 180 by box or slider.

[Ref line color] color palette

Sets the reference line color.

## Rotating Image

- 1 Select measurement data and click the [Process image] button.

Opening/Closing File (Page 3-2)

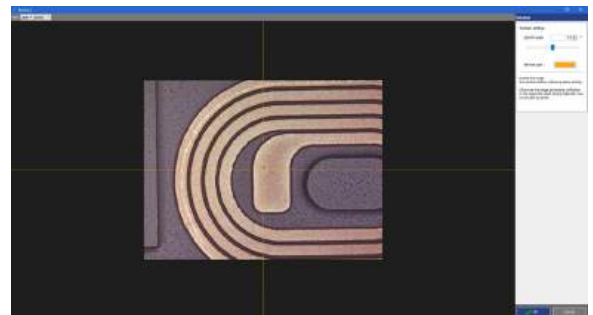
The image processing window opens.

- 2 Click the [Rotation] button.



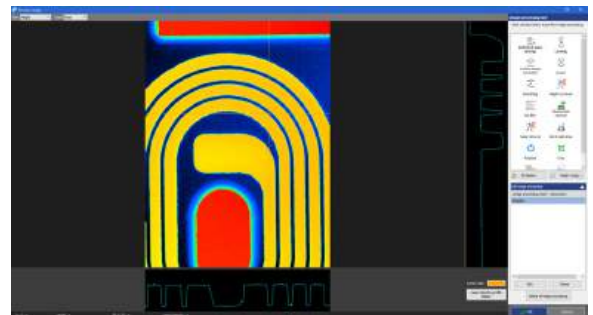
The [Rotation] window appears.

- 3 Set [Rotation settings].



- 4 Click the [OK] button.

The processing results are reflected in the image processing window.



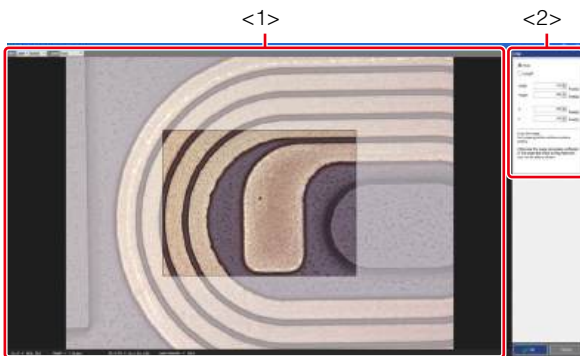
# Image trimming

Crops the image to any size.

## Window Used for Image Trimming

In the image processing window, click the [Crop] button to display the [Crop] window.

The following describes the name and function of parts of the [Crop] window.



### <1> Image display area

Displays the measurement data viewed along a direction perpendicular to the reference plane of the sample.

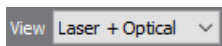
### <2> Crop tool

Set the image trimming.

## Image display area

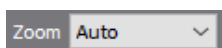
The type of image displayed and magnification level can be adjusted.

[View] box



Select image type.

[Zoom] box



You can select a zoom level for the image.

## Crop tool

[Pixel] radio button

Sets the area unit by pixel.

[Length] radio button

Sets the area unit by length.

[Width] box

Sets the width of the area to be cropped.

[Height] box

Sets the height of the area to be cropped.

[X] box

Sets the X coordinate on the left side of the area to be cropped.

[Y] box

Sets the Y coordinate on the top side of the area to be cropped.

## Cropping Image

### 1 Select measurement data and click the [Process image] button.

Opening/Closing File (Page 3-2)

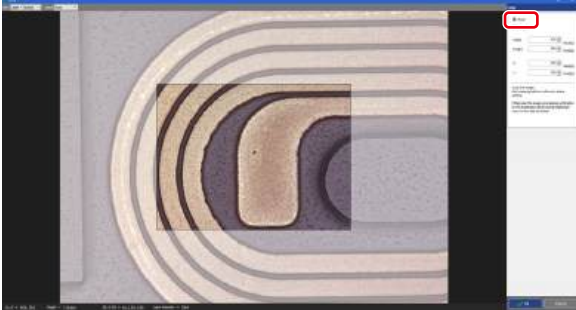
The image processing window opens.

### 2 Click the [Crop] button.

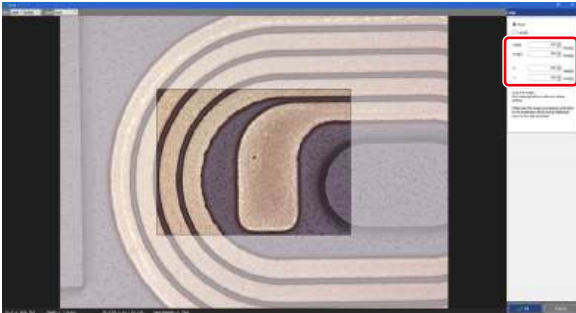


The [Crop] window appears.

- 3** Choose the parameter to crop the area (pixels or length).



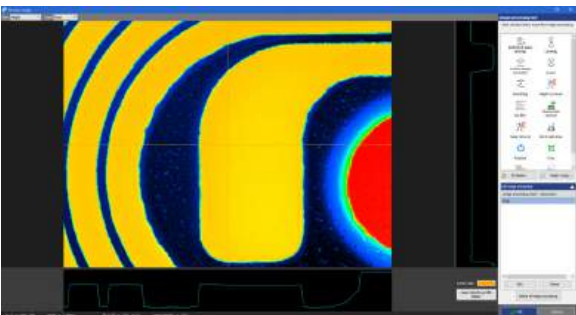
- 4** Sets the size and position of the area to be cropped.



**Reference** You can also set the size and position of the area to be cropped by dragging the frame of the image display area.

- 5** Click the [OK] button.

The processing results are reflected in the image processing window.



# C-DIC setting

## 5

This section describes the adjustment of "C-DIC" images.

- "C-DIC" images

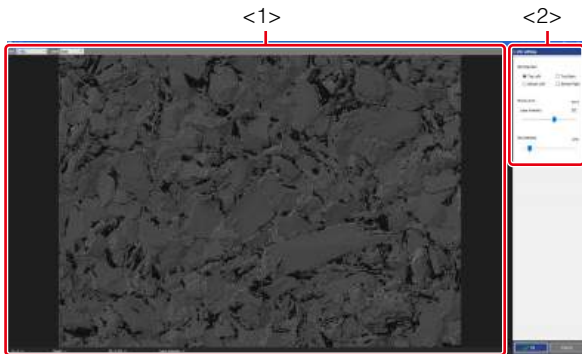
Images highlighting the details of the sample surface, by combining the measured laser intensity and height images and illuminating the minute height differences from an angle through internal processing (differential calculation process).

You can adjust the C-DIC image mixing degree, DIC intensity, and DIC direction.

## Window Used For Adjusting C-DIC Images

In the image processing window, click the [C-DIC setting] button to display the [C-DIC setting] window.

The following describes the name and function of parts of the [C-DIC setting] window.



### <1> Image display area

Displays the main image of the image display window.

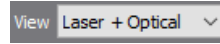
### <2> C-DIC setting tool

Contains sliders and buttons to adjust the image displayed in the image display area.

## Image display area

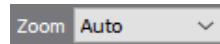
The type of image displayed and magnification level can be adjusted.

### [View] box



Select image type.

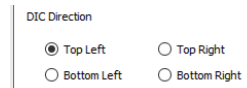
### [Zoom] box



You can select a zoom level for the image.

## C-DIC setting tool

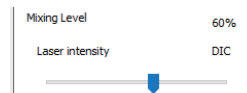
### [DIC Direction] radio button



Selects the position of the light source.

A differential calculation process is executed when you click the [Top Left], [Top Right], [Bottom Left] or [Bottom Right] radio button, projecting the light from the specified direction.

### [Mixing Level] slider



Sets the mixing degree between laser intensity image (HDR) and height differential image (DIC).

Dragging the slider to the left increases the ratio of laser intensity image (HDR), and dragging it to the right increases the ratio of height differential image (DIC).

### [DIC intensity] slider



Sets the strength of the differential calculation process.

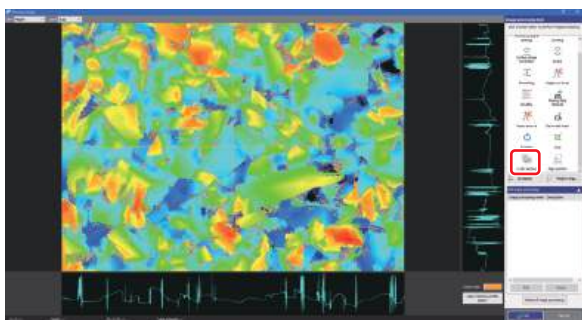
## Adjusting C-DIC Images

- 1 Select measurement data and click the [Process image] button.**

📖 Opening/Closing File (Page 3-2)

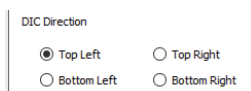
The image processing window opens.

- 2 Click the [C-DIC setting] button.**



The [C-DIC setting] window appears.

- 3 Use the [DIC Direction] radio button to select the position of the light source.**



- 4 Set the mixing degree between laser intensity image (HDR) and height differential image (DIC) using the [Mixing Level] slider.**

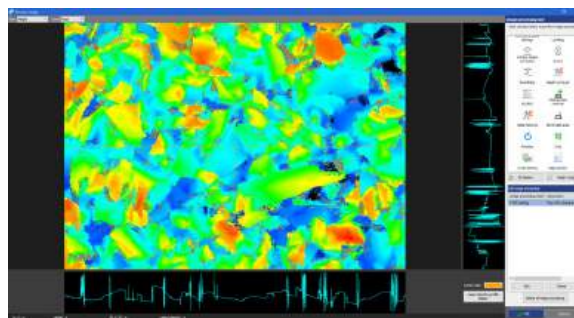


- 5 Set the strength of the differential calculation process using the [DIC intensity] slider.**



- 6 Click the [OK] button.**

The processing results are reflected in the image display window.

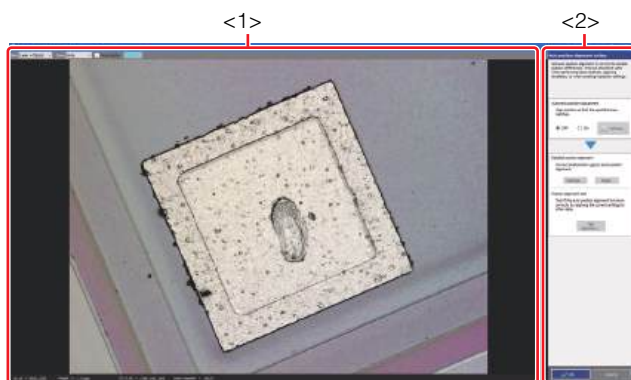


# Auto Position Alignment

Select [Auto position alignment setting] from the [Process image] menu, or click the [Align position] button on the toolbar to display the [Auto position alignment setting] window.

The following describes the names and functions of parts of the [Auto position alignment setting] window.

## Auto Position Alignment Setting Window



### <1> Image display area

Displays the image which is the reference for position alignment.

The selected measurement data is displayed when creating a new image, and the measurement data set as the base data is displayed when editing.

📖 Image display area (Page 5-34)

### <2> Auto position alignment setting tool

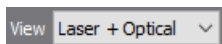
This tool bar includes buttons to configure auto position alignment.

📖 Auto position alignment setting tool (Page 5-34)

## Image display area

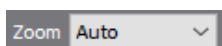
This section describes how to set the type and magnification of the image to be displayed in the image display area, and the area view, the area color and the cursor color.

[View] box



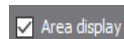
Select image type.

[Zoom] box



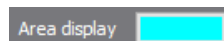
You can select a zoom level for the image.

[Area display] checkbox



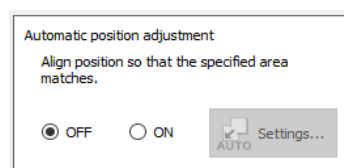
Select whether or not to use the area display.

Color palette



Choose a color for the set area when [Area display] has been selected.

## Auto position alignment setting tool



[OFF] radio button

Turns off the auto position adjustment.

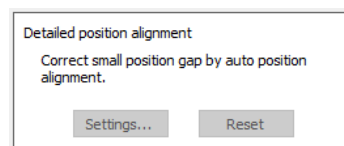
[ON] radio button

Turns on the auto position adjustment.

[Settings] button

Specifies the area used for auto position alignment.

📖 Auto Position Alignment Setting Window (Page 5-37)



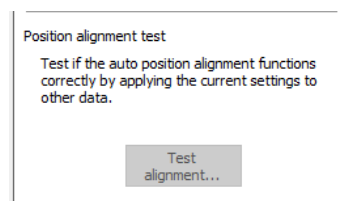
[Settings] button

Performs fine adjustment of the position alignment result that has been set up.

📖 XY Position Alignment Window (Page 5-38)

[Reset] button

Cancels the result after fine adjustment.



[Test alignment] button

Runs a test of position alignment with the specified settings.

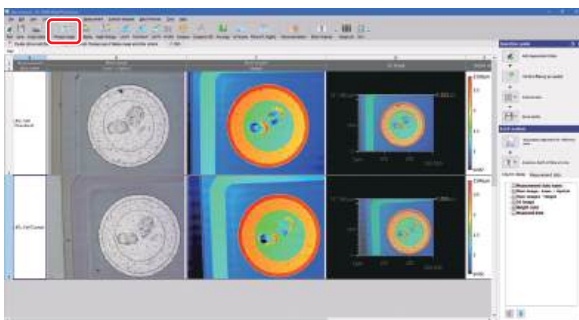
📖 Test Window for Auto Position Alignment (Page 5-39)

## Correcting the Image Position Manually

- 1 Open the base measurement data for position alignment and the correction target measurement data.

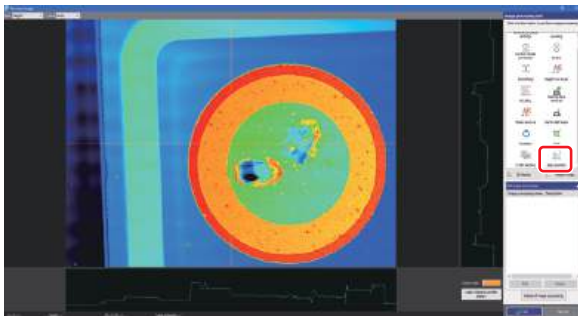
📖 Opening/Closing File (Page 3-2)

- 2 Select the reference measurement data and click the [Process image] button.



The image processing window opens.

- 3 Click the [Align position] button.



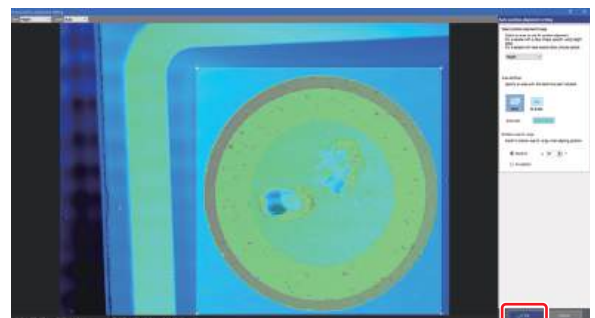
The [Auto position alignment setting] window appears.

- 4 Turn on the [Automatic position alignment] radio button, and then click the [Settings] button.



The [Auto position alignment setting] window appears.

- 5 Set an area and the rotation search range, and click the [OK] button.

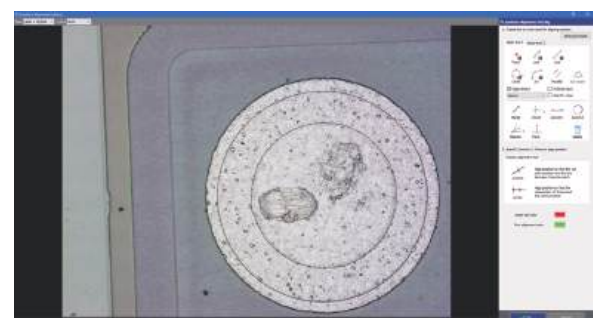


The [Auto position alignment setting] window appears.

- 6 Click the [Settings] button under [Detailed position alignment].

The [XY position alignment setting] window appears.

- 7 Perform position alignment.

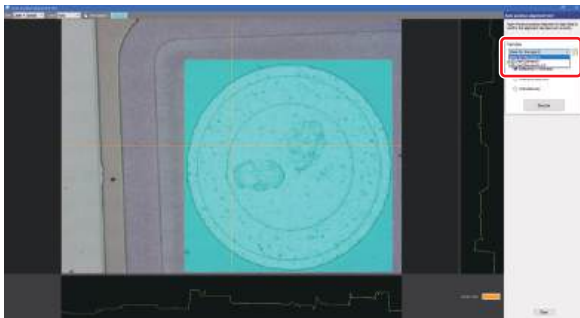


The [Auto position alignment setting] window appears.

**8 Click the [Test alignment] button.**

The [Automatic position alignment test] window appears.

**9 Specify the measurement data for correction in the [Test data] box.**



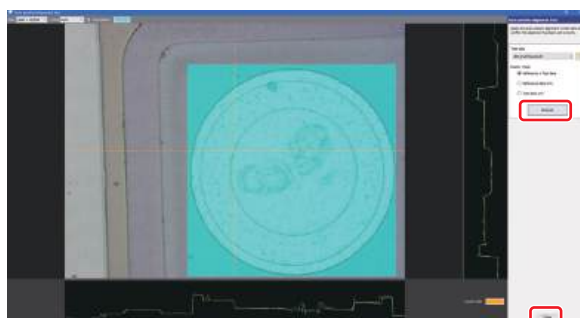
**Reference** When multiple measurement data are open, you can check the correction results of other measurement data by selecting the measurement data for correction in the [Test data] box.

**10 Click the [Execute] button.**

The base measurement data image and the test measurement data are superimposed and displayed in the image display area.

The profile graphs of the base measurement data and the comparison target measurement data are also displayed.

By dragging the vertical or horizontal cursor, you can display the profile graph of any measurement position and check the amount of position difference between the base measurement data and the comparison target measurement data.

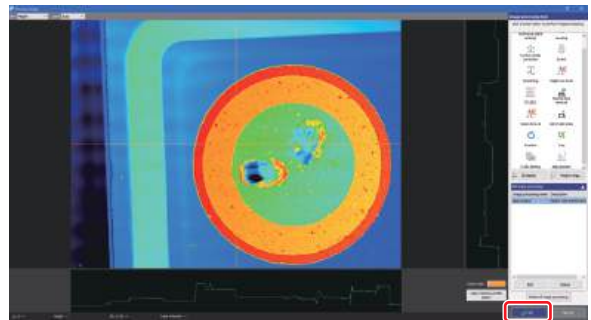


**11 Click the [Close] button.**

The [Auto position alignment setting] window appears.

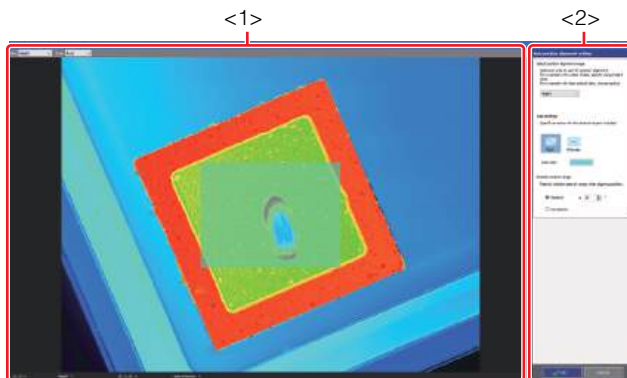
**12 Click the [OK] button.**

The setting is reflected in the image display window.



**Point** To apply the configured auto position alignment result to other measurement data, perform "Unify position alignment/image processing/measurement details". Refer to Unify position alignment/image processing/measurement details (Page 16-4) for details.

## Auto Position Alignment Setting Window



### <1> Image display area

Displays the main image of the image display window.

Image display area (Page 5-37)

### <2> Auto position alignment setting tool

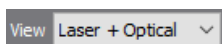
This tool bar includes buttons to configure auto position alignment.

Auto position alignment setting tool (Page 5-37)

## Image display area

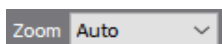
The type of image displayed and magnification level can be adjusted.

### [View] box



Select image type.

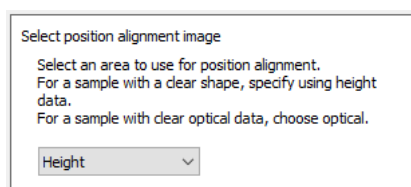
### [Zoom] box



You can select a zoom level for the image.

## Auto position alignment setting tool

### [Select position alignment image] box



### [Height]

Sets the image used in position alignment to the height data.

### [Laser]

Sets the image used in position alignment to the laser data.

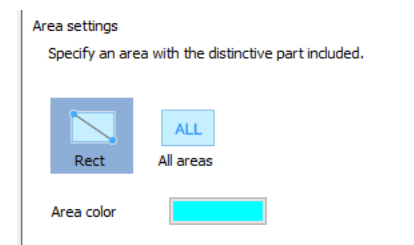
### [Laser intens]

Sets the image used in position alignment to the laser intensity data.

### [Optical]

Sets the image used in position alignment to the color data.

### [Area settings] Tool



### [Rect] button

Selects a rectangle area.

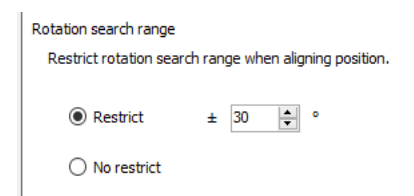
### [All areas] button

Select entire image.

### [Area color] button

Selects an area color for the position alignment displayed in [Image display area].

### [Rotation search range] tool



### [Restrict] radio button

Restricts the rotation search range while performing position alignment.

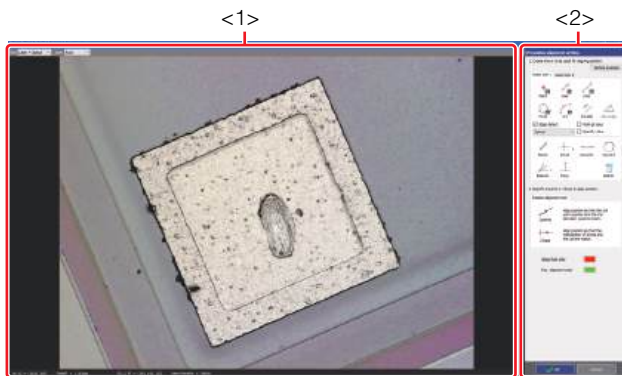
### [Rotation search range] box

Determines the search range while performing rotation search.

### [No restrict] radio button

Does not restrict the rotation search range while performing position alignment.

## XY Position Alignment Window



### <1> Image display area

Displays the main image of the image display window.

Image display area (Page 5-38)

### <2> XY position alignment setting tool

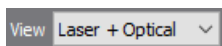
This tool bar includes buttons to configure the advanced position alignment.

XY position alignment setting tool (Page 5-38)

### Image display area

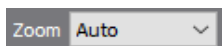
The type of image displayed and magnification level can be adjusted.

[View] box



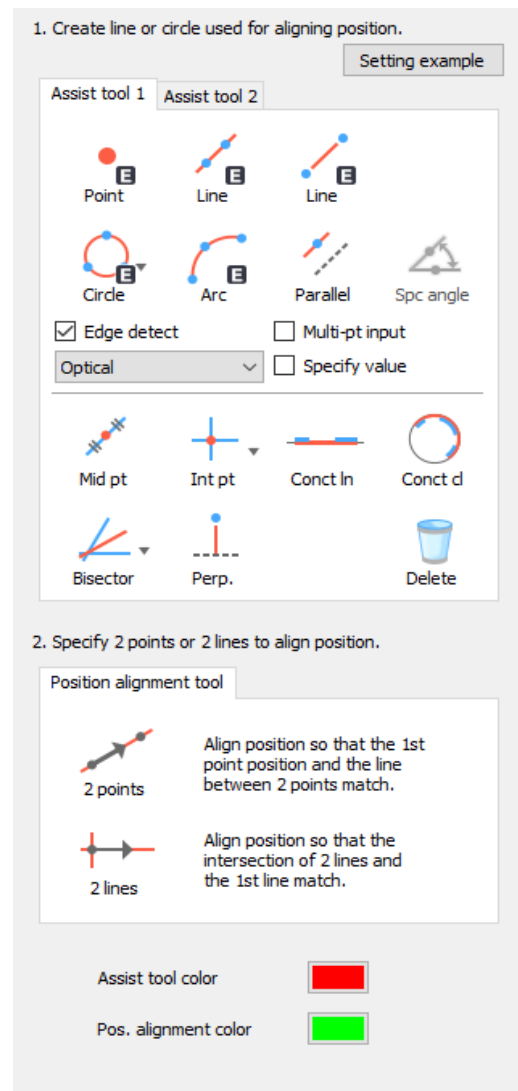
Select image type.

[Zoom] box



You can select a zoom level for the image.

## XY position alignment setting tool



### [Setting example] button

Displays the example of position alignment in another window.

### [Assist tool] area

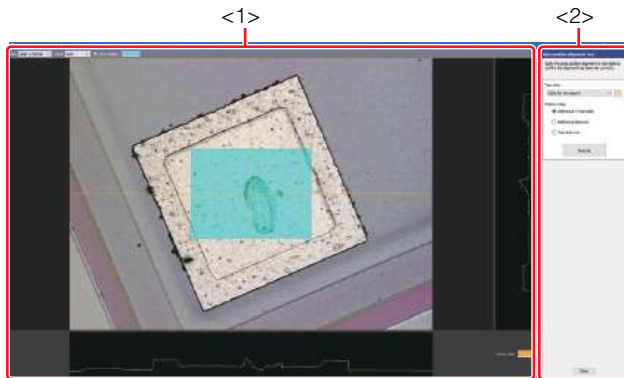
Double-click the [Assist tool 1] tab or [Assist tool 2] tab to draw the assist line for position alignment.

How to use the assist tool (Page A-33)

### [Position alignment tool] area

Select each of the tools to perform the position alignment.

## Test Window for Auto Position Alignment



### <1> Image display area

Displays the position area with the observation image.

Image display area (Page 5-39)

### <2> Automatic position alignment test tool

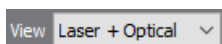
This tool bar includes buttons to run the position alignment test.

Automatic position alignment test tool (Page 5-39)

## Image display area

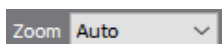
The type of image displayed and magnification level can be adjusted.

### [View] box



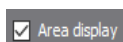
Select image type.

### [Zoom] box



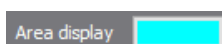
You can select a zoom level for the image.

### [Area display] checkbox



Select whether or not to use the area display.

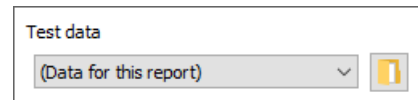
### Color palette



Choose a color for the set area when [Area display] has been selected.

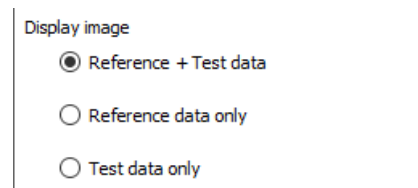
## Automatic position alignment test tool

### [Test data] pull-down list



The test data for position alignment is selected.

### [Display image]



Selects the measurement data displayed in the image display area by radio button.

### [Reference + Test data] radio button

Displays the reference data and the data selected in the [Test data] pull-down list in the image display area.

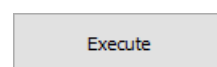
### [Reference data only] radio button

Displays the reference data in the image display area.

### [Test data only] radio button

Displays the data selected in the [Test data] pull-down list in the image display area.

### [Execute] button



Performs auto position alignment with the specified settings.

## MEMO

# Profile Measurement

This chapter describes the profile measurement function found on the [Measurement] menu. This measurement measures the height, distance (length), cross-sectional area, angle, R (arc), etc. of sample for a profile graph of any profile line (straight line and curve) specified on an image.

Flow of Profile Measurement .....	Page 6-2
Screen Used for Profile Measurement .....	Page 6-3
Profile Measurement .....	Page 6-6

# Flow of Profile Measurement

The flow of profile measurement is as follows:

## Setup

### Selecting measurement data

- ▼ On the grid sheet, select the measurement data on which you want to perform profile measurement.  
📖 Opening/Closing File (Page 3-2)

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Leveling
- Surface shape correction
- Inverting an image
- Smoothing
- Height cut level
- DCL/BCL
- Missing data removal
- Noise removal
- Set invalid area
- Screen rotation
- Image trimming
- C-DIC setting
- Auto Position Adjustment

📖 Chapter 5, Measurement Preprocessing (Page 5-1)

## Measurement

### Displaying the profile measurement window

- ▼ Display the profile measurement window to perform measurement.  
📖 Displaying the Profile Measurement Window (Page 6-6)

### Setting profile line

- ▼ Draw a profile line at the measurement position on the image displayed in the profile measurement window. When the profile line is drawn on the image, a profile graph at the measurement position is displayed.

📖 Setting Profile Line (Page 6-7)

### Correcting profile graph

- ▼ As needed, perform a correction to cut the laser intensity level, correct the tilt, and remove the noise in the profile graph.

📖 Correcting the DCL/BCL (Page 6-8)

📖 Performing Smoothing (Page 6-9)

📖 Correcting the Tilt (Page 6-9)

### Setting measurement interval

Change the measurement interval and obtain a measured value of the desired area.

📖 Setting Measurement Intervals (Page 6-10)

## Post-processing

### Exporting measurement result

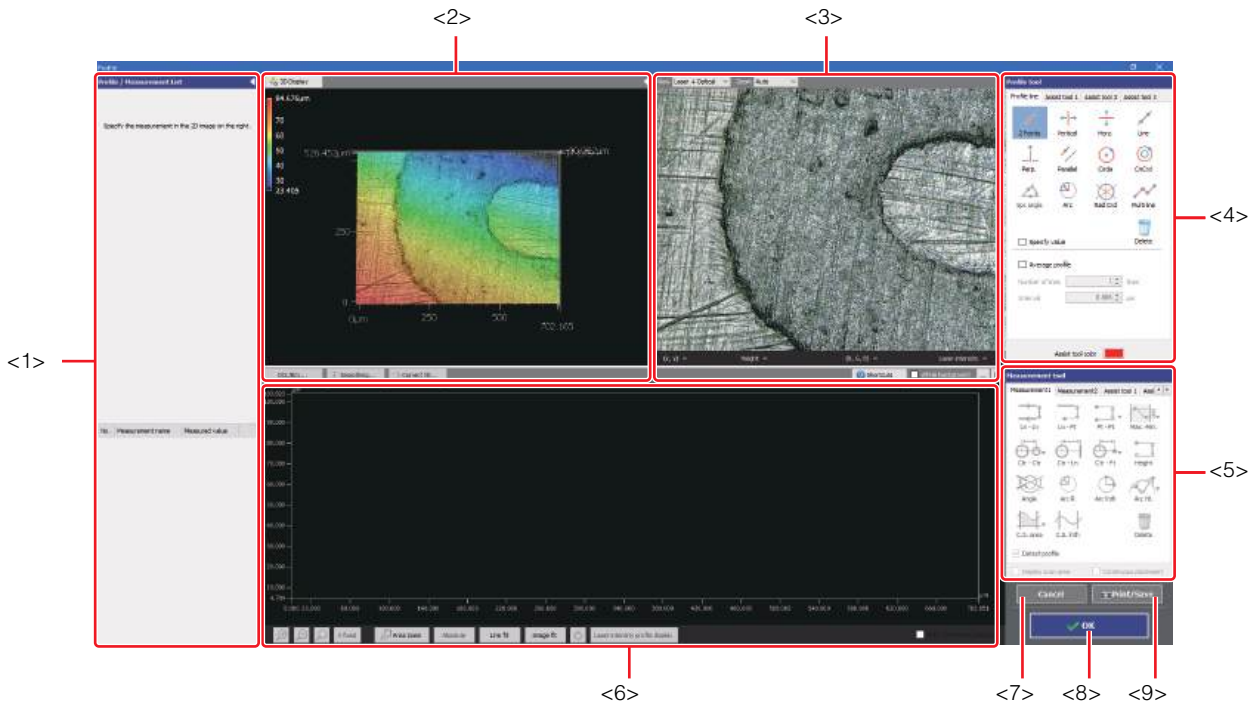
Output the measurement result to Excel file or create a report.

📖 Exporting Measurement Result (Page 6-11)

# Screen Used for Profile Measurement

Select [Profile measurement] from the [Measurement] menu, or click the [Profile] button on the toolbar to display the profile measurement window.

The following describes the name and functions of each part of the profile measurement window.



## <1> Profile/Measurement list

Lists profiles and elements placed on the image, and measurement results.

📖 Profile/Measurement List (Page 6-4)


## <2> 3D display area

Displays a stereoscopic shape of the sample and the cross section of the selected profile. You can change and operate 3D image display.

📖 Configuring Image Display (Page 4-4)

## <3> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. You can set a profile line on this image. You can also change the display type and magnification of the image.

 Changing the display type and the magnification of the image can be done using the [View] box and the [Zoom] box respectively displayed on the upper part of image display area.

## <4> Profile tool

Contains buttons to draw various profile lines, such as a straight line and circles.

📖 Profile Tool (Page A-24)

## <5> Measurement tool

Contains buttons used to measure the interval specified by the profile.

## <6> Profile display area

Displays the profile graph for the profile line (or for the selected profile line for the multi-line ) on the image.

📖 Profile Display Area (Page 6-5)

## <7> [Cancel] button

By clicking, the [Profile] window is closed without applying the setting contents.

## <8> [OK] button

By clicking, the [Profile] window is closed, and the measurement result is applied in the grid sheet.

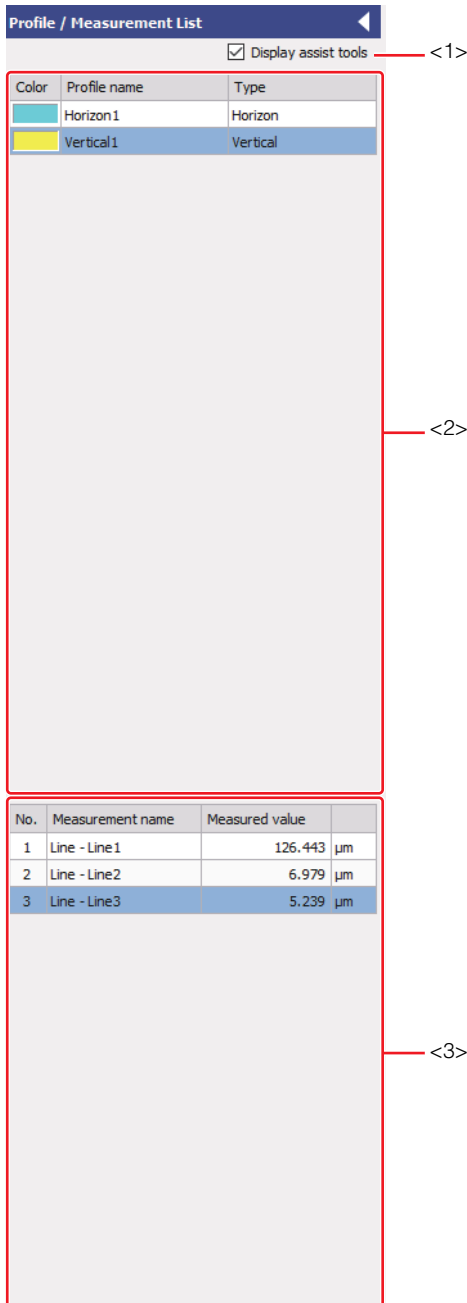
## <9> [Print/Save] button

Output the screen display contents in the following formats.

- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

## Profile/Measurement List

The measurement results list displays the list of profiles and elements placed on the image, and the list of measurement results.



### <1> [Display assist tools] checkbox

Selecting this checkbox displays the list of the assist tools in the profile list.

### <2> Profile list

Displays the list of profile lines and assist tools.

The element being selected in the image display area is highlighted in this list.

### <3> Measured value

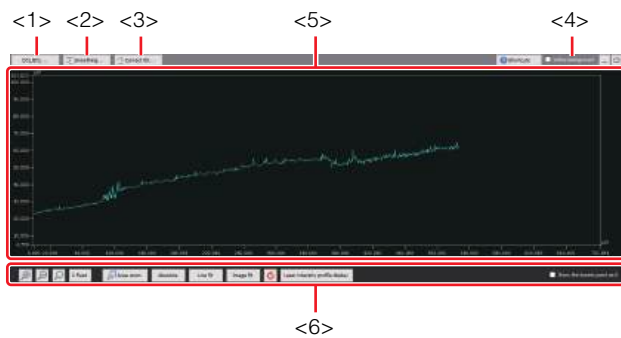
Displays the following measured values of the selected profile in the image display area.

Item	Description
Line - Line	Distance between line and line.
Line - Point	Distance between line and point.
Point - Point	Distance between two points.
Max. and min.	Values of the maximum and minimum points in the direction of the Z axis within the specified interval.
Circle - Circle	Distance between circles.
Circle - Line	Distance between circle and line.
Circle - Point	Distance between circle and point.
Height	Measures height relative to reference plane.
Angle	Angle between two lines at their intersection.
Arc R	Radius value of circle or arc.
Arc length	Periphery distance value of circle or arc.
Arc height	Radius value between arc and profile.
C.S. area	Area value between line or arc and profile.
C.S. length	Specified interval profile length.
Corner R	Radius value of a circle which is formed by two lines.
Chamfer	Value of C plane (45 degrees corner cutting).



Click the button to collapse and hide the profile/measurement results list into the left edge of the window. Click the button to display it again.

## Profile Display Area



### <1> [DCL/BCL] button

DCL (Dark Cut Level)/BCL (Bright Cut Level) interpolates the height data above the dark cut level (lower threshold) or the bright cut level (upper threshold) with the surrounding data when a portion of the laser intensity of the laser intensity profile graph is judged as abnormal (too low or too high).

### <2> [Smoothing] button

Applies smoothing filter to the profile.

### <3> [Correct tilt] button

Performs tilt correction for total profile line.

### <4> [White background] checkbox


Select this checkbox to make the background color white.

### <5> Profile display area

Displays the profile graph obtained by using the profile line settings.

### <6> Profile operation controls

Changes the method to view the profile graph.

 Changing the method to view the profile graph (Page 6-33)


# Profile Measurement

## Displaying the Profile Measurement Window

Display the profile measurement window to perform measurement.

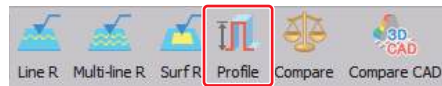
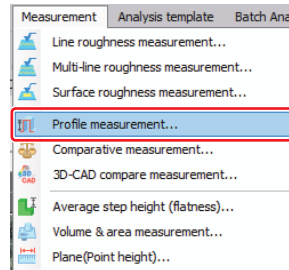
### 1 Open the measurement data or analysis result file.

Opening/Closing File (Page 3-2)

 Perform the following preprocessing as needed.

- Reference Plane Settings
  - Opening/Closing File (Page 5-3)
- Leveling
  - Opening/Closing File (Page 5-9)
- Surface shape correction
  - Opening/Closing File (Page 5-11)
- Inverting an Image
  - Opening/Closing File (Page 5-16)
- Smoothing
  - Opening/Closing File (Page 5-17)
- Height cut level
  - Opening/Closing File (Page 5-19)
- DCL/BCL
  - Opening/Closing File (Page 5-22)
- Missing data removal
  - Opening/Closing File (Page 5-25)
- Noise removal
  - Opening/Closing File (Page 5-26)
- Set invalid area
  - Opening/Closing File (Page 5-28)
- Screen rotation
  - Opening/Closing File (Page 5-29)
- Image trimming
  - Opening/Closing File (Page 5-30)
- C-DIC setting
  - Opening/Closing File (Page 5-32)
- Auto Position Adjustment
  - Opening/Closing File (Page 5-34)

### 2 Select [Profile measurement] from the [Measurement] menu. Or click the [Profile] button on the toolbar.



The profile measurement window appears.


## Setting Profile Line

Set a profile line at the measurement position on the image displayed in the profile measurement window. When the profile line is specified on the image, a profile graph at the measurement position is displayed.

- 1 **Select the [Assist tool 1] tab, [Assist tool 2], or [Assist tool 3] tab in the profile tool, and click the desired button to place an element on the image as needed.**

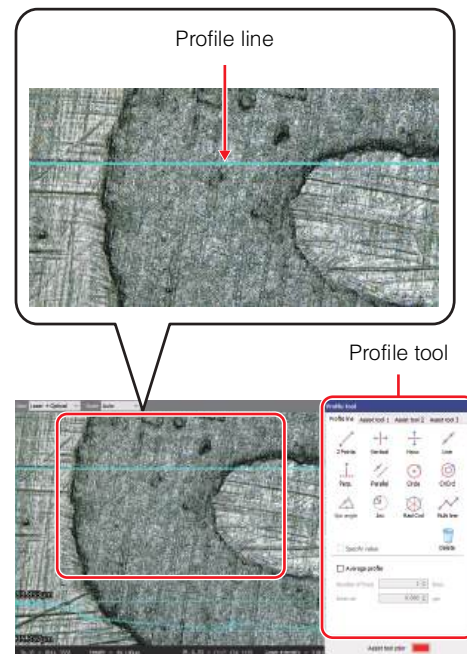
A profile line consists of elements such as point and line. If you place these elements on the measurement position in advance using the buttons on the [Assist tool 1] tab, [Assist tool 2] tab, or [Assist tool 3] tab, you can draw a profile line accurately and efficiently in a way that is similar to actual drawing.

 What is an Element? (Page A-22)

 How to use assist tools (Page 6-25)

- 2 **Click the desired button on the [Profile line] tab in the profile tool and draw a profile line on the image.**

 How to use profile line tool (Page A-26)



When a profile line is drawn on the image, an actual cross section profile graph is displayed in the profile display area.

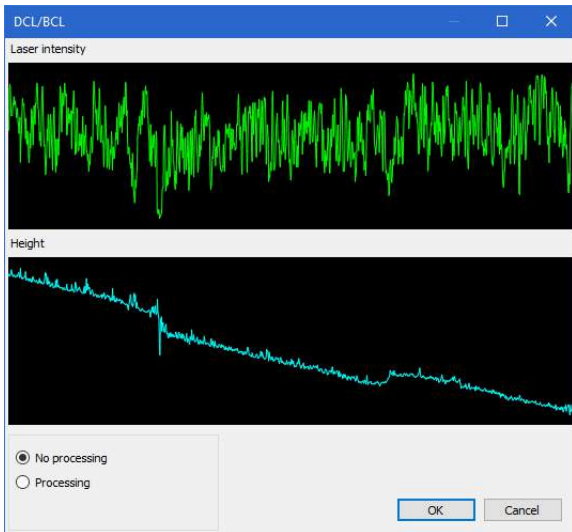
Because the profile graph is updated in real time during the drawing process of the profile line, you can draw the profile line while confirming the waveform. Additionally, the Profile/Measurement List displays the profile list.

## Correcting the DCL/BCL

DCL (Dark Cut Level)/BCL (Bright Cut Level) cuts the laser intensity level above the dark cut level (lower threshold) or the bright cut level (upper threshold) with the surrounding data when a portion of the laser intensity of the laser intensity profile graph is judged as abnormal (too low or too high).

- 1 Click the [DCL/BCL] button in the profile display area.

The [DCL/BCL] window appears.



- 2 Click the [Processing] radio button.

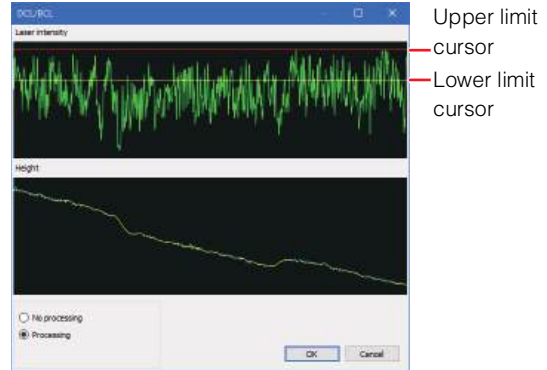
### [No processing] radio button

The changes in DCL/BCL are not reflected in the display.

### [Processing] radio button

Smooths height data (cross section Profile) by smoothing and cutting level processing.

- 3 Drag the upper limit and lower limit cursors to set the threshold.



The height profile graph after correction is displayed in the [DCL/BCL] window.

### Upper limit cursor

The laser intensity data higher than the cursor will be cut (bright areas).

### Lower limit cursor

The laser intensity data lower than the cursor will be cut (dark areas).

- 4 Click the [OK] button in the [DCL/BCL] window.

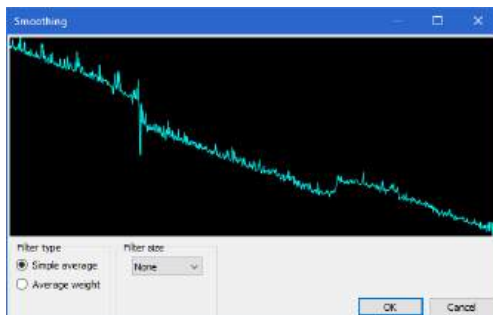
This executes the correction.

## Performing Smoothing

The smoothing operation makes a waveform of graph smoother by averaging measured data. Perform this where required.

### 1 Click the [Smoothing] button in the profile display area.

The [Smoothing] window appears.



### 2 Select a filter type.

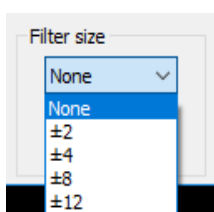
#### [Simple average] radio button

Simply averages the height data in the intervals specified in [Filter size]. This averaging method greatly reduces noise, but profiles, such as edges, become softer as well.

#### [Average weight] radio button

Multiplies height data in the intervals specified in [Filter size] by a weighting factor, and then performs calculation. This averaging method makes shapes smoother, preserving the sharpness of edges as much as possible.

### 3 Select a filter size.



### 4 Click the [OK] button in the [Smoothing] window.

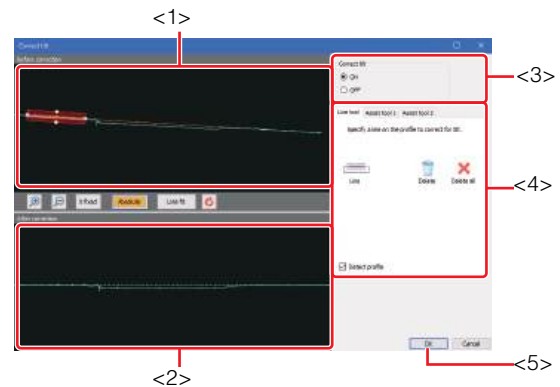
This executes the correction.

## Correcting the Tilt

Corrects for the tilt of the profile along a specified line. Perform this where required.

### 1 Click the [Correct tilt] button.

The [Correct tilt] window appears.



### 2 Select the [Assist tool] tab (<4>) and click the desired button to place an element on the profile as needed.

A measurement area consists of elements such as point and line. If you place these elements on the measurement position in advance using the buttons on the [Assist tool] tab, you can set a measurement area accurately and efficiently in a way that is similar to actual drawing.

📖 Types and Setting of Measurement Intervals (Page 6-12)

📖 How to use assist tools (Page 6-25)

### 3 Select the [Line tool] tab (<4>) and click the [Line] button.

### 4 Click the start point of the part where the tilt is leveled to the profile of the area before correction (<1>), and move the mouse pointer.

If the mouse pointer is moved, the position which will be the ending point is displayed.

### 5 Click a position to be the end point.

The profile after correction appears in the area after correction (<2>).

**6 Click the [OK] button (<5>) in the [Correct tilt] window.**

The tilt correction is executed.



- When redoing the tilt correction, open the [Correct tilt] window again, and use the assist tool (<4>).
- If clearing the tilt correction, select the [OFF] radio button (<3>) and click the [OK] button (<5>).

**Setting Measurement Intervals**

Set measurement intervals on the profile displayed on the profile display area, and obtain measurement values for each interval.

**1 Select the [Assist tool 1] tab or [Assist tool 2] tab in the measurement tool and click the desired button to place an element on the profile as needed.**

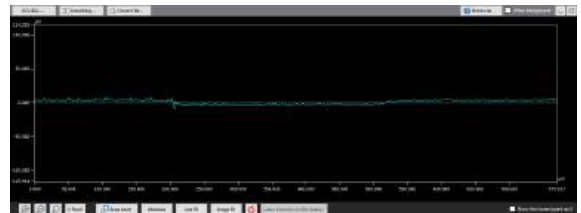
A measurement area consists of elements such as point and line. If you place these elements on the measurement position in advance using the buttons on the [Assist tool 1] tab or [Assist tool 2] tab, you can set a measurement area accurately and efficiently in a way that is similar to actual drawing.

Types and Setting of Measurement Intervals (Page 6-12)

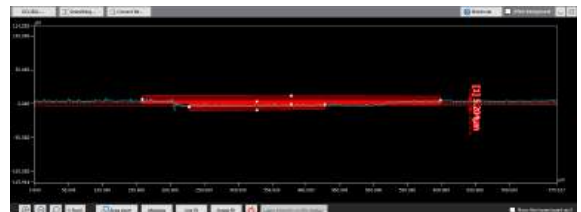
How to use assist tools (Page 6-25)

**2 Click the desired button on the [Measurement1] tab or [Measurement2] tab in the measurement tool and set a measurement area on the profile.**

How to use measurement tool (Page 6-14)



When the measurement area is set on the profile, the measured value appears in the profile display area and in the profile/measurement list.

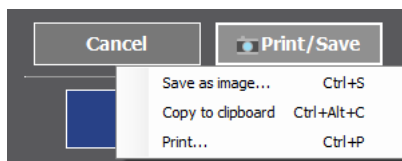


## Outputting the Screen Display Contents

Output the contents displayed in the screen as image data with the format of any of copy, print, or save.

**1** Select the [Print/Save] button.

**2** Select the format to be output.



- Save as image  
The [Save as image] dialog box appears.  
Select the format from PNG, JPEG, or TIFF for saving.
- Copy to clipboard  
The image data is copied to the PC clipboard.
- Print  
The [Print] dialog box appears.  
If necessary, adjust the print settings, then print.

## Applying the Measurement Result in the Main Screen

**1** Click the [OK] button in the [Profile] window.

The [Profile] window is closed, and the measurement result is applied in the grid sheet.

**Reference** By clicking the [Cancel] button, the [Profile] window is closed without applying the setting contents.

## Operating the Grid View Area

Measurement data information and measurement analysis results are displayed on the grid view area. For setting the display contents, see the following.

- Grid view area (Page 2-8)
- Inserting items (Page 2-11)
- Sorting (Page 2-12)

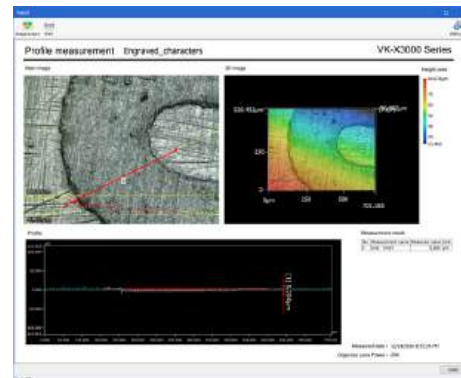
## Exporting Measurement Result

Profile measurement results can be output to a report or an Excel file.

### ●Report output

Outputs the results in a defined format in another window.

Refer to Report (Page 3-9).



### ●Exporting to Excel file

Outputs the image data and text to Excel in grid display layout.

Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to Exporting as Excel File (Page 3-15).

### ●Save CSV


Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

Refer to Exporting measurement result (Page 3-13).

## Types and Setting of Measurement Intervals

### Measurement tool elements

For further information including definition of elements, refer to  What is an Element? (Page A-22).

#### ■ Element placement

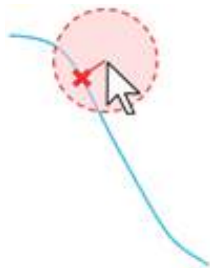
In the measurement tool, a certain scan area is determined around the place specified with the mouse and an element is placed at the position on the profile included in the scan area. However, if there is an existing element within the scan area, the element is given priority.

#### Point

- When the [Detect profile] checkbox is deselected, an element is placed without the element scan area used.
- When the [Display scan area] checkbox is selected, even after the element is placed, the element scan area is displayed.

#### ● Point element

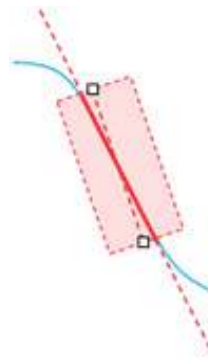
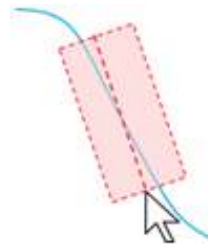
The nearest existing point element in a circle that has the clicked point as a center and a radius of an element scan distance is detected. When there is no existing element, a point element is placed on the nearest point on the profile.



#### ● Line element

If there is a reusable line element within the element scan distance from the clicked point, the line element is specified.

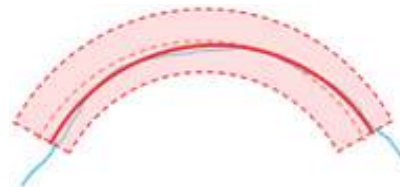
When there is no existing element, a rectangle is obtained by widening the width of a line segment that passes through the two specified points by the line scan distance first. Then, a line is obtained by calculating from a profile shape that is in the rectangle area using the least squares method, and a line segment that is in the rectangle area is placed as a line element.



#### ● Circle element

If there is a circle element (i.e. a valid circle or arc) within the element scan distance from the clicked point, the circle element is specified.

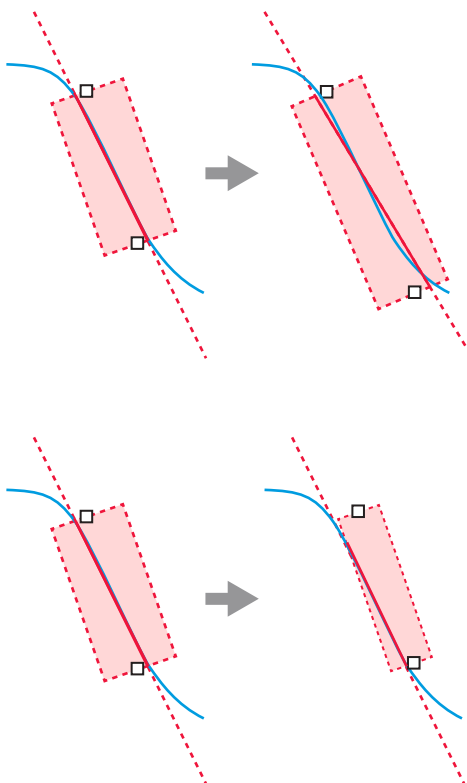
Otherwise, an arch shape is obtained by widening the width of a circular arc that passes through the three specified points by the line scan distance first. Then, a circle is obtained by calculating from a profile shape that is in the arch shape area using the least squares method, and a circular arc that is in the arch shape area is placed as an element.



### ■ Element detection area

After placing the element, the size of the detection area can be changed.

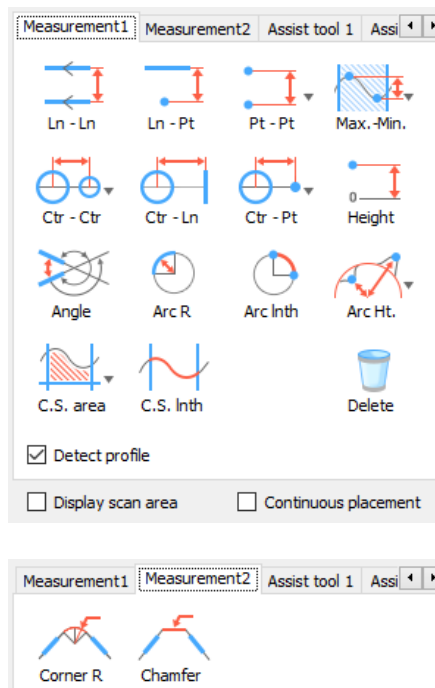
After changing the detection area, the element placing area can be changed.



### Measurement tool











In the measurement tool, click a button of each tool to set various measurement intervals. Click a tool button to select the tool. While the tool is selected, click or drag in the profile display area to place an element of the tool. Once the element is placed, the tool will be deselected.


When a measurement interval is set, height, distance (length), cross-sectional area, angle, and R (Arc) within a certain interval can be measured.





The following describes the function of each button and checkbox.


#### [Measurement] tab


- 
Measures the distance between a line and a line.  
 Line - Line measurement (Page 6-14)
- 
Measures the distance between a line and a point.  
 Line - Point measurement (Page 6-15)
- 
Measures the distance between two points.  
 Point - Point measurement (Page 6-15)
- 
Measure the distance between maximum and minimum points on the Z axis direction within the specified area.  
 Measuring Max. and Min. (Page 6-16)
- 
Measures the distance between two circles.  
 Circle - Circle measurement (Page 6-17)


 Measures the distance between a circle and a line.  
 Circle - Line measurement (Page 6-17)


 Measures the distance between a circle and a point.  
 Circle - Point measurement (Page 6-18)


 Measures height relative to reference plane.  
 Height measurement (Page 6-18)


 Measures the angle between two lines at their intersection.  
 Measurement of the angle (Page 6-19)


 Measures the radius of a circle or an arc.  
 Arc R measurement (Page 6-19)


 Measures the periphery distance.  
 Arc length measurement (Page 6-20)


 Specify an arc, and measure the maximum and minimum distance to the profile from the arc center point.  
 Arc Height measurement (Page 6-20)

 Measure the area between a line or an arc and profile.  
 Cross sectional area measurement (Page 6-21)

 Measures the profile length of a specified interval.  
 Cross sectional length measurement (Page 6-22)

 Measures the Corner R (radius).  
 Corner R measurement (Page 6-22)

 Measure the dimension of chamfered edge (45 degrees corner cutting).  
 Chamfer measurement (Page 6-23)

 Deletes the specified measurement intervals.

**[Detect profile] checkbox**

When this checkbox is deselected, the measurement is performed using the coordinates where the element is placed without performing profile detection.

**[Display scan area] checkbox**

When this checkbox is selected, the element scan area is displayed around the element placed in the profile display area.


**[Continuous placement] checkbox**

When this checkbox is selected, the tool selection state is maintained, the element can be placed repeatedly.

**How to use measurement tool**

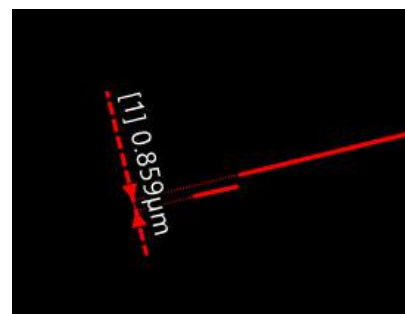
The following describes how to set a measurement interval using the measurement tool.

**■ Line - Line measurement**

 Measures the distance between two lines.

Reusable element at the time of placement  
 Line, Point

Reusable element after the placement  
 Line 1, Line 2



**1** Click the [Ln - Ln] button.

**2** Specify Line 1.

**3** Specify Line 2.

The measured value follows the mouse pointer and is displayed in the measurement list.

**4** Click the position to display the measured value.

The position to display the measured value is determined.

### Line - Point measurement



Measures the shortest distance between a line and a point.

Reusable element at the time of placement

Line, Point

Reusable element after the placement

Line, Point



**1** Click the [Ln - Pt] button.

**2** Specify the line.

**3** Specify the point.

The measured value follows the mouse pointer and is displayed in the measurement list.

**4** Click the position to display the measured value.

The position to display the measured value is determined.

### Point - Point measurement



Measures the distance between two points.

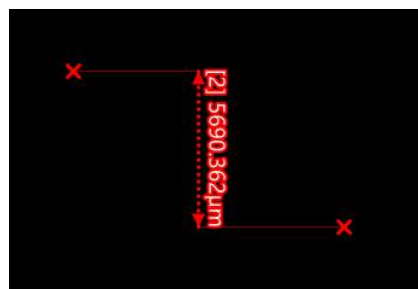
Reusable element at the time of placement

Point

Reusable element after the placement

Point 1, Point 2

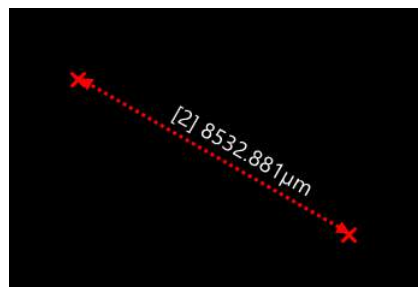
[Vertical distance]



[Horizontal distance]



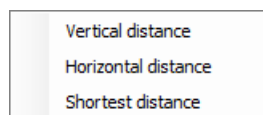
[Shortest distance]



**1** Click the [Pt - Pt] button.

The measurement type menu is displayed.

**2** Select the measurement type.



### 3 Specify Point 1 and Point 2.

Click the desired places to specify two points.  
The measured value follows the mouse pointer and is displayed in the measurement list.

### 4 Click the position to display the measured value.

The position to display the measured value is determined.

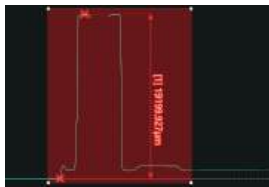
### ■ Measuring Max. and Min.



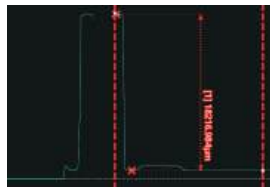
Measure the distance between maximum and minimum points on the Z axis direction within the specified area.

Reusable element at the time of placement  
Point (when an interval is specified)

Reusable element after the placement  
Point (max. and min.)



(measurement type: when a rectangle is specified)

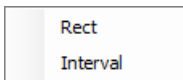


(measurement type: when an interval is specified)

### 1 Click the [Max.-Min.] button.

The measurement type menu is displayed.

### 2 Select the measurement type.



The following procedures differ depending on the measurement type.

#### ● When [Rect] is selected

### 1 Click the start point of the area, and move the mouse pointer.

When you move the mouse pointer, a rectangle area is displayed accordingly.

### 2 Release left-click to define the area.

The measured value follows the mouse pointer and is displayed in the measurement list.

### 3 Click the position to display the measured value.

The interval is determined and the maximum and minimum measurement values are placed.

#### ● When [Interval] is selected

### 1 Click the line 1 which will be the interval starting point, and move the mouse pointer.

The vertical line (a line parallel to the Z-axis) is displayed at the position which will be the interval starting point.

If the mouse pointer is moved, the vertical line is displayed at the position which will be the interval ending point.

### 2 Click the line 2 which will be the interval ending point, and move the mouse pointer.

The measured value follows the mouse pointer and is displayed in the measurement list.

### 3 Click the position to display the measured value.

The interval is determined and the maximum and minimum measurement values are placed.

### ■ Circle - Circle measurement



Measures the distance between two circles.

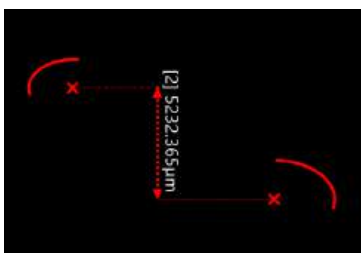
Reusable element at the time of placement

Circle, Arc, Point

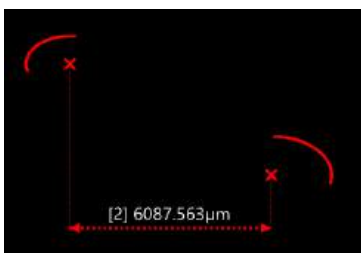
Reusable element after the placement

Circle 1, Circle 2, Point (center point of the circle)

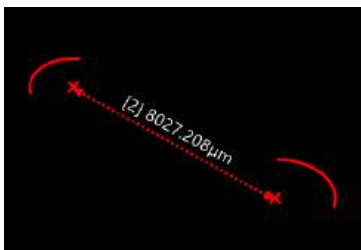
[Vertical distance]



[Horizontal distance]

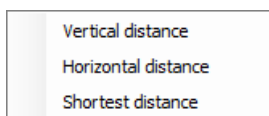


[Shortest distance]



- 1 Click the [Ctr - Ctr] button.**  
The measurement type menu is displayed.

- 2 Select the measurement type.**



- 3 Specify Circle 1 and Circle 2.**  
The measured value follows the mouse pointer and is displayed in the measurement list.

- 4 Click the position to display the measured value.**  
The position to display the measured value is determined.

### ■ Circle - Line measurement



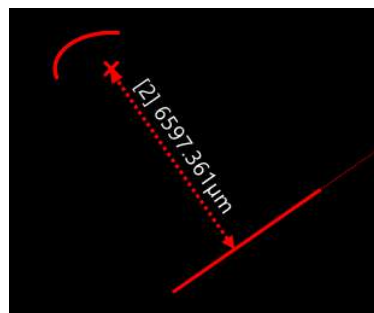
Measures the distance between a circle and a line.

Reusable element at the time of placement

Circle, Arc, Line, Point

Reusable element after the placement

Circle, Line, Point (center point of the circle)



- 1 Click the [Ctr - Ln] button.**
- 2 Specify a circle.**
- 3 Specify the line.**  
The measured value follows the mouse pointer and is displayed in the measurement list.
- 4 Click the position to display the measured value.**  
The position to display the measured value is determined.

**Circle - Point measurement**

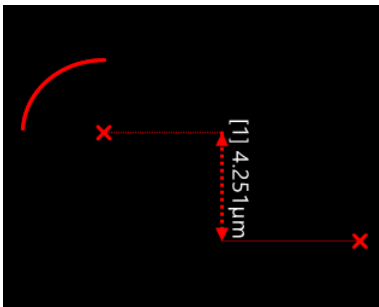


Measures the distance between a circle and a point.

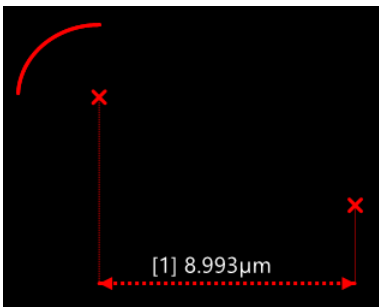
Reusable element at the time of placement  
Circle, Arc, Point

Reusable element after the placement  
Circle, Point, Point (center point of the circle)

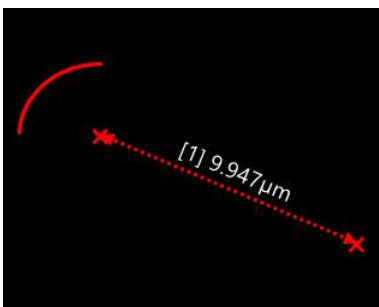
[Vertical distance]



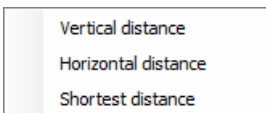
[Horizontal distance]



[Shortest distance]



- 1 Click the [Ctr - Pt] button.**  
The measurement type menu is displayed.
- 2 Select the measurement type.**



- 3 Specify a circle.**

- 4 Specify the point.**

The measured value follows the mouse pointer and is displayed in the measurement list.

- 5 Click the position to display the measured value.**

The position to display the measured value is determined.

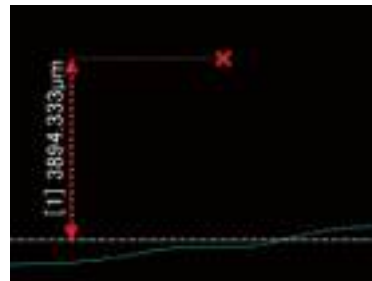
**Height measurement**



Measures height relative to reference plane.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Point



- 1 Click the [Height] button.**
- 2 Specify the point.**  
Click the desired places to specify one point.  
The measured value follows the mouse pointer and is displayed in the measurement list.
- 3 Click the position to display the measured value.**  
The position to display the measured value is determined.

## ■ Measurement of the angle



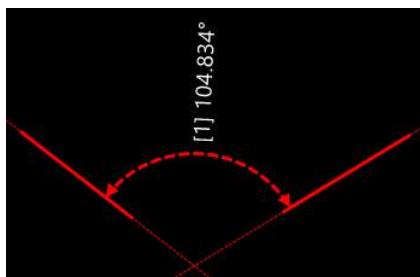
Measures the angle between two lines at their intersection.

Reusable element at the time of placement

Line, Point

Reusable element after the placement

Line 1, Line 2



- 1** Click the [Angle] button.
- 2** Specify Line 1.
- 3** Specify Line 2.
- 4** Specify which of the angles made by the two lines will the angle to be measured.

When you move the mouse pointer, the position of the angle to be measured is indicated by an arrow with a dotted line. Click when the position to be measured is indicated.

The measured value follows the mouse pointer and is displayed in the measurement list.

- 5** Click the position to display the measured value.

The position to display the measured value is determined.

## ■ Arc R measurement



Measures the radius of arc.

Reusable element at the time of placement

Circle (Arc), Point

Reusable element after the placement

Arc, Point (center point of the arc)



- 1** Click the [Arc R] button.
- 2** Specify a circle.
 

The measured value follows the mouse pointer and is displayed in the measurement list.
- 3** Click the position to display the measured value.

The position to display the measured value is determined.

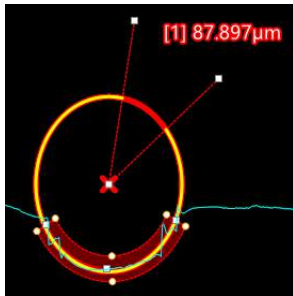
### ■ Arc length measurement



Measures the periphery distance.

Reusable element at the time of placement  
Circle (Arc), Point

Reusable element after the placement  
Arc, Point



- 1** Click the [Arc Inth] button.
- 2** Specify the circle 1.
- 3** Specify the point 1 and 2.

The fan shaped extracted area is drawn from point 1 to 2. The measured values follows the mouse pointer after specifying point 2.

- 4** Click the position to display the measured value.

The position to display the measured value is determined.

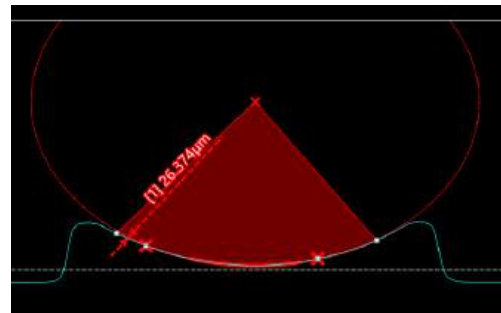
### ■ Arc Height measurement



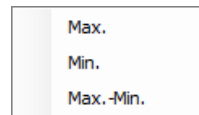
Specify an arc, and measure the maximum and minimum distance of the profile from the arc center point.

Reusable element at the time of placement  
Arc, Circle, Point

Reusable element after the placement  
Arc, Point



- 1** Click the [Arc Ht.] button.  
The measurement type menu is displayed.
- 2** Select the measurement type.



- 3** Specify the arc 1.
- 4** Specify the point 1 and 2.  
The fan shaped extracted area is drawn from point 1 to 2. The measured values follows the mouse pointer after specifying point 2.
- 5** Click the position to display the measured value.

The position to display the measured value is determined.

## ■ Cross sectional area measurement



Measures the area between a line or arc and the profile.

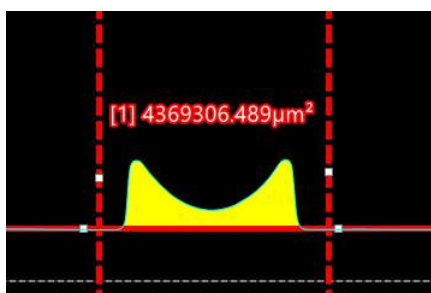
Reusable element at the time of placement

Line, Arc, Circle, Point

Reusable element after the placement

Line, Arc

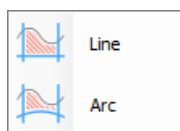
### ● Line



#### 1 Click the [C.S. area] button.

The measurement type menu is displayed.

#### 2 Select [Line] from the displayed menu.



#### 3 Specify Line 1.

A vertical line (a line vertical to the line 1) is displayed as a thick dotted line.

#### 4 Click to specify vertical line 1 and 2.

The extracted area surrounded by line 1 and profile line within the range of vertical line 1 and 2 is drawn. As for the extracted area, its position where the mouse pointer exists is drawn.

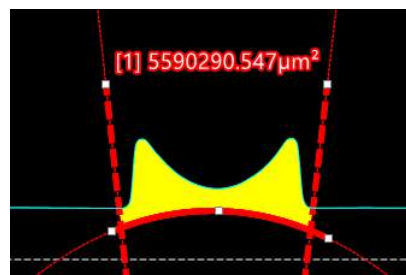
#### 5 Click the extracted area to be measured.

The extracted area is determined, and drawn by yellow.

#### 6 Click the position to display the measured value.

The position to display the measured value is determined.

### ● Arc



#### 1 Click the [C.S. area] button.

The measurement type menu is displayed.

#### 2 Select [Arc] from the displayed menu.

#### 3 Specify the arc 1.

A vertical line (a line passing through the center point of the arc 1) is displayed as a thick dotted line.

#### 4 Specify the point 1 and 2.

The extracted area surrounded by arc and profile line within the range of the point 1 and 2 is drawn. As for the extracted area, its position where the mouse pointer exists is drawn.

#### 5 Click the extracted area to be measured.

The extracted area is determined, and drawn by yellow.

#### 6 Click the position to display the measured value.

The drawing area is determined, and the position to display the measured value is determined.

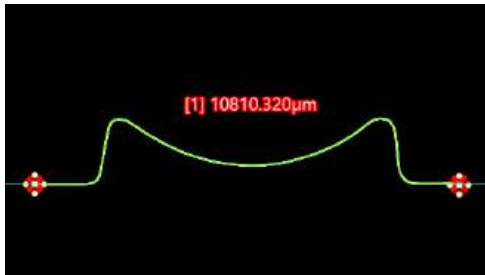
### ■ Cross sectional length measurement



Measures the profile length of a specified interval.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Point



- 1** Click the [C.S. Inth] button.
- 2** Click the position which will be the interval starting point, and move the mouse pointer.

A point is displayed at the position which will be the interval starting point.  
If the mouse pointer is moved, the point is displayed at the position which will be the interval ending point.

- 3** Click the position which will be the interval ending point, and move the mouse pointer.

The area to be measured is filled with yellow.  
The measured value follows the mouse pointer and is displayed in the measurement list.

- 4** Click the position to display the measured value.

The position to display the measured value is determined.

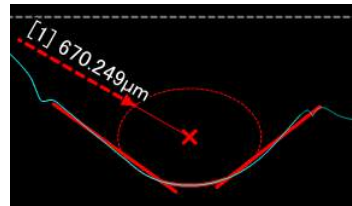
### ■ Corner R measurement



Measures the Corner R (radius).

Reusable element at the time of placement  
Line, Point

Reusable element after the placement  
Line 1, Line 2, Arc, Point (center point of the arc)



- 1** Click the [Corner R] button.

- 2** Specify Line 1.

- 3** Specify Line 2.

The measured value follows the mouse pointer and is displayed in the measurement list.

- 4** Click the position to display the measured value.

The position to display the measured value is determined.

## ■ Chamfer measurement



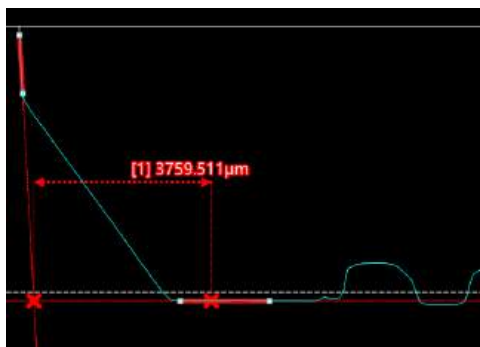
Measure the dimension of the specified Chamfer edge (45 degrees corner cutting).

Reusable element at the time of placement

Line, Point

Reusable element after the placement

Line, Point



**1** Click the [Chamfer] button.

**2** Specify Line 1.

**3** Specify Line 2.

The measured value follows the mouse pointer and is displayed in the measurement list.

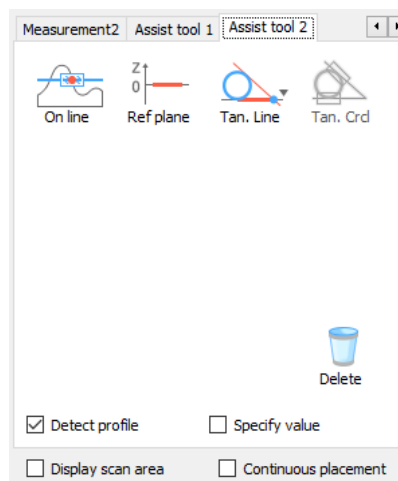
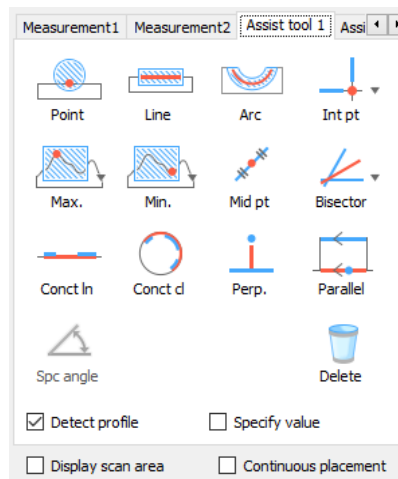
**4** Click the position to display the measured value.

The position to display the measured value is determined.

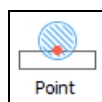
## [Assist tool] tab

Elements you create using the assist tool are called assist elements. Assist elements do not create any measurements, instead, they can be used as a reference points or lines when you set a measurement interval.

Placing assist elements at measurement points, enables you to set measurement intervals more accurately and efficiently.

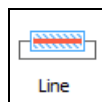


The following describes the function of each button and checkbox.



Specifies a point which is on the profile and nearest to the clicked point.

📖 [Point] button (Page 6-25)




Specifies a line that fits to the profile near the line you specified by clicking two points.


📖 [Line] button (Page 6-25)





Extracts an arc by clicking 3 points on the profile.


📖 [Arc] button (Page 6-25)


 Specifies the intersection of two lines, a line and a circle, or two circles.  
 [Int pt] button (Page 6-26)


 Specifies the maximum point in the direction of the Z axis within the specified interval.  
 [Max.] button (Page 6-26)


 Specifies the minimum point in the direction of the Z axis within the specified interval.  
 [Min.] button (Page 6-27)


 Specifies the middle point between two points.  
 [Mid pt] button (Page 6-27)


 Specify the two lines, a line and a point, or bisector of two points.  
 [Bisector] button (Page 6-28)


 Creates a line by joining lines.  
 [Conct ln] button (Page 6-28)


 Creates a circle by joining arcs.  
 [Conct cl] button (Page 6-29)


 Specifies a point on the perpendicular line of a line.  
 [Perp.] button (Page 6-29)


 Specifies a parallel line of the line.  
 [Parallel] button (Page 6-30)


 Specifies a line which is intersecting at a specified angle with the line.  
 [Spc angle] button (Page 6-30)

 Specifies the intersection of the profile inside the specified area and the specified line.  
 [On line] button (Page 6-31)

 Places a line at the position of the reference plane of a specified point.  
 [Ref plane] button (Page 6-31)

 Specifies a tangent line of a circle and a point, or of two circles.  
 [Tan. Line] button (Page 6-32)

 Specify a circle that connects the two points.  
 [Tan. Crd] button (Page 6-32)

 Deletes the created assist tool or element.

**[Detect profile] checkbox**

When this checkbox is deselected, the measurement is performed using the coordinates where the element is placed without performing profile detection.

This cannot be used for [Max.], [Min.], [On line], [Conct ln], or [Conct cl].

**[Specify value] checkbox**

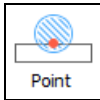
When this checkbox is selected, the assist tool can be set after specifying the value. Only used with [Parallel] and [Spc angle].

**[Display scan area] checkbox**

When this checkbox is selected, the element scan area is displayed around the element placed in the profile display area.

## How to use assist tools

### ■ [Point] button



An element that expresses a point.

Reusable element at the time of placement

None

Reusable element after the placement

Point

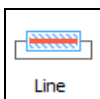


#### 1 Click the [Point] button.

#### 2 Click an arbitrary position.

A point is placed.

### ■ [Line] button



A line element that expresses a line segment on the profile.

Reusable element at the time of placement

Point

Reusable element after the placement

Line



#### 1 Click the [Line] button.

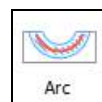
#### 2 Click the first arbitrary point, and move the mouse pointer.

When you move the mouse pointer, a rubber band of the line scan area is displayed.

#### 3 Click the second arbitrary point.

A line is placed on the profile.

### ■ [Arc] button



An element that creates an arc on the profile.

Reusable element at the time of placement

Point

Reusable element after the placement

Arc, Point (center point of the arc)



#### 1 Click the [Arc] button.

#### 2 Click the first point on the circle and move the mouse pointer.

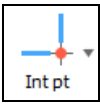
#### 3 Click the second point on the circle, and move the mouse pointer.

When you move the mouse pointer, a rubber band of the arc extract area is displayed.

#### 4 Click the third point.

An arc is placed on the profile.

■ [Int pt] button



Creates the intersection of two lines, a line and a circle, or two circles as a point element.

Reusable element at the time of placement  
Line, Circle, Arc, Point

Reusable element after the placement  
Circle, Line, Point (intersection)



(Measurement type: when line - line is specified)

- 1 Click the [Int pt] button.
- 2 Select the measurement type.
 

Line - Line  
 Circle - Line  
 Circle - Circle
- 3 Specify the 1st line or circle.
 

Specify a line and a circle in the same way as [Line] and [Circle].
- 4 Specify the 2nd line or circle.
 

Specify a line and a circle in the same way as [Line] and [Circle].

When you specify them, the intersection of line and line, circle and line, or circle and circle is placed according to the measurement type you selected.

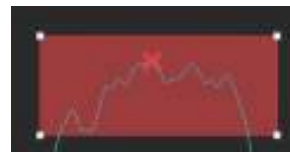
■ [Max.] button



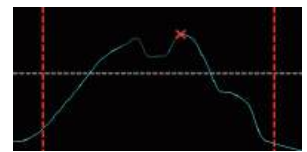
Creates the maximum point as a point element in the direction of the Z axis within the specified area.

Reusable element at the time of placement  
Point (when an interval is specified)

Reusable element after the placement  
Point (Maximum point)

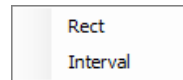


(measurement type: when a rectangle is specified)



(measurement type: when an interval is specified)

- 1 Click the [Max.] button.
- 2 Select the measurement type.



The following procedures differ depending on the measurement type.

- When [Rect] is selected
- 3 Click the start point of the area, and move the mouse pointer.
 

When you move the mouse pointer, a rectangle area is displayed accordingly.
  - 4 Release left-click to define the area.
 

The area is determined and the maximum point is placed.
- When [Interval] is selected
- 3 Click the position which will be the interval starting point, and move the mouse pointer.
 

The vertical line (a line parallel to the Z-axis) is displayed at the position which will be the interval starting point.

If the mouse pointer is moved, the vertical line is displayed at the position which will be the interval ending point.
  - 4 Click the position which will be the interval ending point, and move the mouse pointer.
 

The measured value follows the mouse pointer and is displayed in the measurement list.
  - 5 Click the position to display the measured value.
 

The area is determined and the maximum point is placed.

## ■ [Min.] button



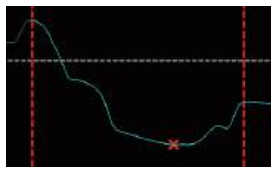
Creates the minimum point as a point element in the direction of the Z axis within the specified area.

Reusable element at the time of placement  
Point (when an interval is specified)

Reusable element after the placement  
Point (Minimum point)

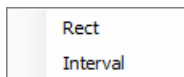


(measurement type: when a rectangle is specified)



(measurement type: when an interval is specified)

- 1 Click the [Min.] button.
- 2 Select the measurement type.



The following procedures differ depending on the measurement type.

### ● When [Rect] is selected

- 3 Click the start point of the area, and move the mouse pointer.  
When you move the mouse pointer, a rectangle area is displayed accordingly.
- 4 Release left-click to define the area.  
The area is determined and the minimum point is placed.

### ● When [Interval] is selected

- 3 Click the position which will be the interval starting point, and move the mouse pointer.  
The vertical line (a line parallel to the Z-axis) is displayed at the position which will be the interval starting point.  
If the mouse pointer is moved, the vertical line is displayed at the position which will be the interval ending point.
- 4 Click the position which will be the interval ending point, and move the mouse pointer.  
The measured value follows the mouse pointer and is displayed in the measurement list.

- 5 Click the position to display the measured value.  
The area is determined and the minimum point is placed.

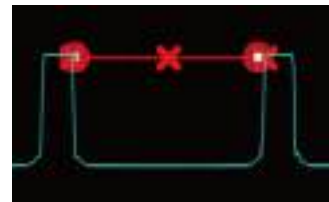
## ■ [Mid pt] button



Creates a middle point of two points as a point element.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Point (Middle point)



- 1 Click the [Mid pt] button.
- 2 Click the first arbitrary point, and move the mouse pointer.
- 3 Click the second arbitrary point.  
The middle point of the specified two points is placed.



Only when the [Detect profile] checkbox is deselected, the line segment and middle point are displayed when moving the mouse pointer.

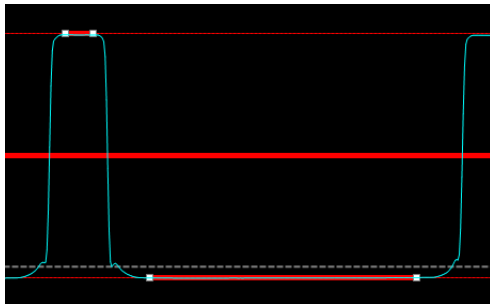
■ [Bisector] button



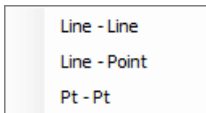
Creates the bisector of two lines, a line and a point, or two points as line element.

Reusable element at the time of placement  
Point, Line, Segment

Reusable element after the placement  
Line (Bisector)



- 1 Click the [Bisector] button.
- 2 Select the measurement type.



- 3 Specify the 1st line or point.  
Specify a straight line or point in the same way as [Line] or [Point].
- 4 Specify the 2nd line or point.  
Specify a straight line or point in the same way as [Line] or [Point].  
A bisector is placed.  
After selecting [Line-Line] in measurement type, if the specified two lines are intersecting, go to the next step.
- 5 Click the interior angle (or the exterior angle) that intersects the two straight lines which were specified.  
The bisector in the interior angle (or exterior angle) intersected by the two specified lines is placed.

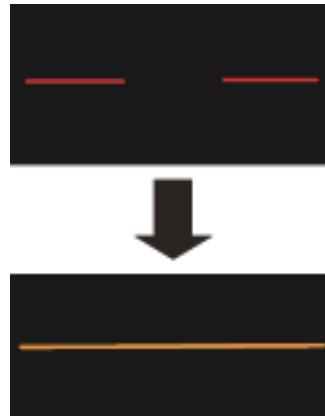
■ [Conct In] button



Creates a line that joins more than one line.

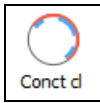
Reusable element at the time of placement  
Point, Line

Reusable element after the placement  
Line



- 1 Click the [Conct In] button.
- 2 Select an existing line element or point element.
- 3 Repeat Step 2.  
Up to 10 elements can be selected.
- 4 When you have finished selecting, double-click any point or select [Confirm] from the right-click menu.  
A new line element is placed based on the selected point elements and the sets of points that created the line elements.

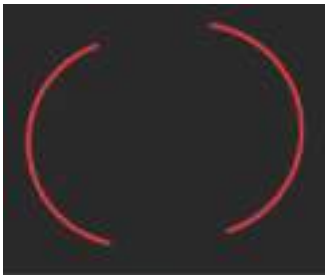
## ■ [Conct cl] button



Creates a circle that connects multiple arcs.

Reusable element at the time of placement  
Point, Circle, Arc

Reusable element after the placement  
Circle



- 1 Click the [Conct cl] button.**
- 2 Select an existing circle element or point element.**
- 3 Repeat Step 2.**  
Up to 10 elements can be selected.
- 4 When you have finished selecting, double-click any point or select [Confirm] from the right-click menu.**  
A new circle element is placed based on the selected point elements and the sets of points that created the circle elements.

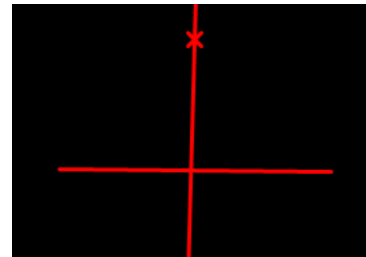
## ■ [Perp.] button



Creates a point on the perpendicular line of a line as point element.

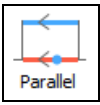
Reusable element at the time of placement  
Line, Point

Reusable element after the placement  
Line



- 1 Click the [Perp.] button.**
- 2 Specify the line.**  
Specify a straight line in the same way as [Line].  
After being specified, the line perpendicular to the line element will be displayed.
- 3 Move the mouse pointer.**  
When you move the mouse pointer, a perpendicular line is moved accordingly.
- 4 Click an arbitrary position.**  
A perpendicular line is placed.

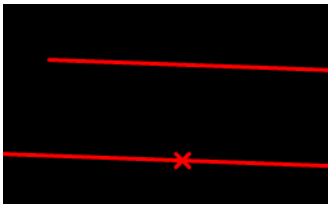
■ [Parallel] button



Creates a parallel of a line as line element.

Reusable element at the time of placement  
Line, Point

Reusable element after the placement  
Line



**1** Click the [Parallel] button.

**2** Specify the line.

Specify a straight line in the same way as [Line].  
After being specified, the parallel line will be displayed.

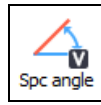
**3** Move the mouse pointer.

When you move the mouse pointer, the parallel line is moved accordingly.

**4** Click an arbitrary position.

The parallel line is placed.

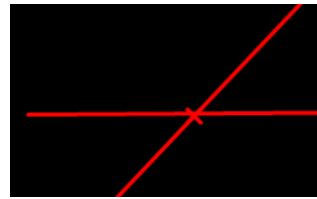
■ [Spc angle] button



Creates a line which is intersecting at a specified angle with the line as line element.

Reusable element at the time of placement  
Line, Point

Reusable element after the placement  
Line

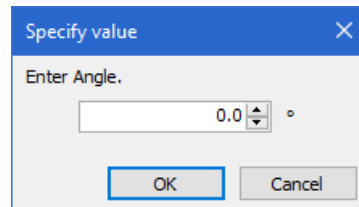


**1** Select the [Specify value] checkbox.

**2** Click the [Spc angle] button.

The [Specify value] dialog box appears.

**3** Enter an angle against the line, and click the [OK] button.



**4** Specify the line.

Specify a straight line in the same way as [Line].  
After being specified, the line which is intersecting at a specified angle will be displayed.

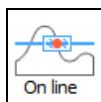
**5** Move the mouse pointer.

When you move the mouse pointer, a straight line is moved accordingly.

**6** Click a point arbitrarily.

A line is placed.

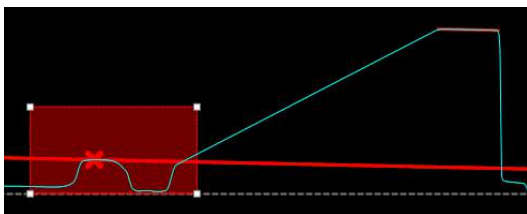
### ■ [On line] button



Creates the intersection of the profile inside the specified area and the specified line as point element.

Reusable element at the time of placement  
Line, Point

Reusable element after the placement  
Line, Point

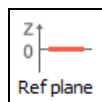


- 1 Click the [On line] button.**
- 2 Click the start point of the area, and move the mouse pointer.**  
When you move the mouse pointer, a rectangle area is displayed accordingly.
- 3 Release left-click to define the area.**  
The area is confirmed.
- 4 Click the first arbitrary point, and move the mouse pointer.**  
When you move the mouse pointer, a rubber band of the line scan area is displayed.
- 5 Click the second arbitrary point.**  
The line element is calculated.  
The intersection of the extended line of line element and the profile line is placed as a point.



When there are multiple intersections, the one closest to the upper left will be placed.

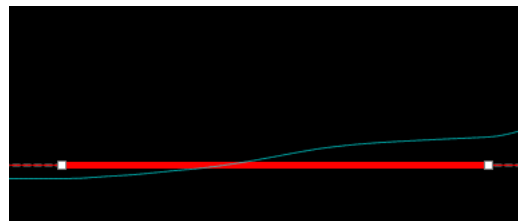
### ■ [Ref plane] button



Places a line at the position of the reference plane of a specified point.

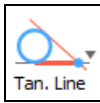
Reusable element at the time of placement  
None

Reusable element after the placement  
Line



- 1 Click the [Ref plane] button.**
- 2 Click the first arbitrary point, and move the mouse pointer.**
- 3 Click the second arbitrary point.**  
Places a line at the position of the reference plane of a specified point.

■ [Tan. Line] button



Specifies two circles, or a circle and a line, and creates a line which connects the two elements as line element.

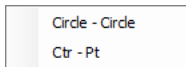
Reusable element at the time of placement  
Point, Circle

Reusable element after the placement  
Line, Point (contact point)



1 Click the [Tan. Line] button.

2 Select the measurement type.



3 Specify a circle.

Specify a circle in the same way as [Circle].

4 Specify a point or a circle.

Specify a point or a circle in the same way as [Point] and [Circle].

5 Specify a place where the tangent line goes through.

A line is placed.

■ [Tan. Crd] button



A circle of specified diameter can be placed and the tangential points to the profile extracted.

Reusable element at the time of placement  
None

Reusable element after the placement  
Circle, Point (center point of the circle, 2 contact points)



1 Select the [Specify value] checkbox.

2 Click the [Tan. Crd] button.

The [Specify value] dialog box appears.

3 After entering the circle diameter, click the [OK] button.

4 Click the center of the circle.

The intersection of the circle element and the profile line is placed as a point.

## Editing/deleting elements

This section describes editing/deleting of elements you placed using the measurement tool (including measurement results).

### ■ Select

You can select elements by any of the following operations:

- Click a desired element in the profile display area.
- Select a desired element from the measurement list (measurement results only).

You can select more than one element at the same time by clicking them while pressing the Ctrl or Shift key.



In the profile display area, the selection status of the measurement result is synchronized. If you select a measurement result in either area, the result is selected and highlighted in both areas.

### ■ Resizing/moving

For further information on the resizing/moving, refer to

What is an Element? (Page A-22).

### ■ Rename

By default, the tool name of the measurement tool followed by a sequential number is used as the name. For example, the first measurement result set by [Ln - Ln] is Line - Line 1.

You can rename a measurement result by any of the following operations in the measurement list:

- Click a measurement name in the row of the desired measurement result.
- Select [Rename] from the right-click menu of the row of the desired measurement result.

### ■ Delete

You can delete elements by any of the following operations while elements are selected.

- Press the Delete key.
- Select [Delete] from the right-click menu.
- Click the [Delete] button in the measurement tool.

### ■ Reproduction

The selecting element can be reproduced by Ctrl+Shift+Left drag.

## Changing the method to view the profile graph

You can enlarge/reduce/fit a view of a profile graph by clicking each button in the profile operation controls.

The following describes the functions of each button.



Enlarges 1.5 times the original magnification. This is the same as [Enlarge] in the right-click menu.



Reduces 2/3 times the original magnification. This is the same as [Reduce] in the right-click menu.



Displays the [Set axis] dialog box for the profile measurement.

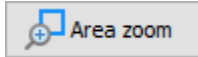
Set axis			
X Axis	Max:	770.327	µm
	Min:	-0.797	µm
Z Axis	Max:	114.555	µm
	Min:	-115.961	µm
		OK	Cancel

In the [Set axis] dialog box, you can set a display area for each of the X and Z axis with the maximum and minimum values.

- **[X fixed] button**

Fixes the scaling of the X axis of the profile.

- **[Area zoom] button**



Specifies a rectangular area on the profile graph by clicking two points or dragging the mouse, then the profile graph in the specified rectangular area is enlarged to fit to the entire profile display area.

- **[Absolute] button**

Adjusts the scaling of the X and Z axis of the profile to make the aspect ratio 1:1.

- **[Line fit] button**

Enlarges or reduces the entire profile graph to fit it to the entire profile display area.

- **[Image fit] button**

Adjusts the maximum or minimum of the Z axis in the profile display area to the maximum or minimum of the entire height image. Or adjust the X axis to fit the profile graph to the entire profile display area.

- **[Reset] button**



Resets the scaling of the X and Z axes.

- **[Laser intensity profile display] button**

The laser intensity profile is displayed.

- **[Show the lowest point as 0] checkbox**

The scaling of the Z axis is adjusted with the lowest point of the profile graph set to 0.

# Chapter 7

## Plane Measurement (Point Height)

This chapter describes the plane measurement function found on the [Measurement] menu. The plane measurement offers two measurement modes, which are plane measurement and XY measurement.

In the plane measurement, you can specify a measurement line (straight line, circle and angle) on an image and measure its distance, angle, etc. Also, the number of points clicked on the image is counted.

In the XY measurement, the sample is surrounded by horizontal cursors and vertical cursors, and distances in the X and Y directions and a length of the diagonal line on the sample are measured.

Flow of Plane Measurement (Point Height) ....	Page 7-2
Screen Used for Plane Measurement (Point Height) ...	Page 7-3
Plane Measurement (Point Height) .....	Page 7-5
Plane measurement (auto measurement) ...	Page 7-9

# Flow of Plane Measurement (Point Height)

The flow of Plane Measurement (Point height) is as follows:

## Setup

### Selecting measurement data

On the grid sheet, select the measurement data on which you want to perform plane measurement (Point height).

Opening/Closing File (Page 3-2)

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Leveling
- Surface shape correction
- Inverting an image
- Smoothing
- Height cut level
- DCL/BCL
- Missing data removal
- Noise removal
- Set invalid area
- Screen rotation
- Image trimming
- C-DIC setting
- Auto Position Adjustment

Chapter 5, Measurement Preprocessing (Page 5-1)

## Measurement

### Displaying the plane measurement window

Displays the plane measurement window to perform measurement.

Displaying the Plane Measurement (Point Height) Window (Page 7-5)

### Setting Measurement Line

Draw a measurement line at the measurement position on the image displayed in the plane measurement window.

When the measurement line is set, the measurement results at the measurement position are displayed.

Setting Measurement Line (Page 7-6)

### XY measurement

To perform the XY measurement, display the XY measurement lines and adjust their positions.

When the XY measurement lines are displayed, the measurement results of the position surrounded by the lines are displayed.

Performing XY Measurement (Page 7-7)

### Counting no. of points

To check the number of points, place points on the image.

If the points are placed, the number will be displayed.

Counting the Number of Points (Page 7-7)

## Post-processing

### Exporting measurement result

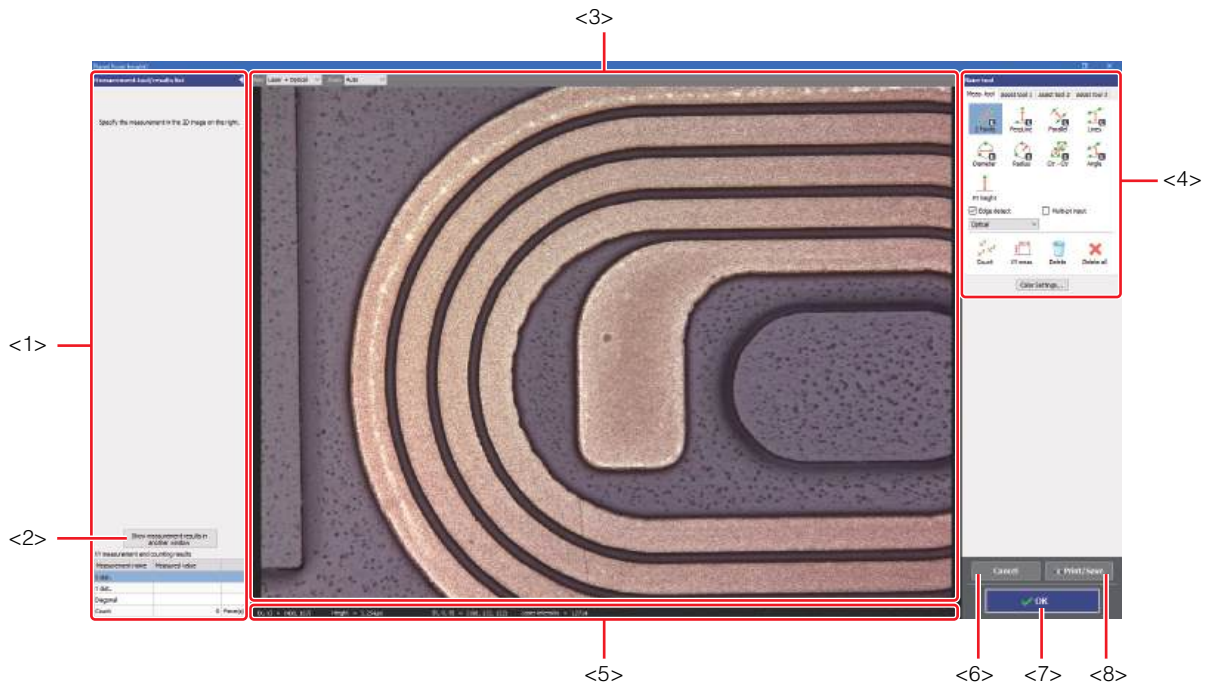
Output the measurement result to Excel file or create a report.

Exporting Measurement Result (Page 7-8)

# Screen Used for Plane Measurement (Point Height)

Select [Plane (Point height)] from the [Measurement] menu, or click the [Plane (Pt. height)] button on the toolbar to display the plane measurement (Point height) window.

The following describes the name and functions of each part of the plane measurement (Point height) window.



## <1> Measurement tool/results list

Displays the list of measurement tools used for plane measurement (point height) and the list of measurement results.


 Measurement tool/results list (Page 7-4)

## <2> [Show measurement results in another window] button

Displays the result displayed on the measured value in a different window. The displayed result can be saved as a text file in CSV format.

## <3> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. You can set measurement lines on this image. You can also change the display type and magnification of the image.

 Changing the display type and the magnification of the image can be done using the [View] box and the [Zoom] box respectively displayed on the upper part of image display area.

## <4> Plane tool

Contains buttons to draw various measurement lines, such as a straight line or a circle.

 Plane Measurement Tool (Page A-54)

## <5> Status bar

The X and Y coordinates of the mouse placed on the image display area, and the height, RGB values and laser intensity at the coordinates are displayed.

## <6> [Cancel] button

By clicking, the [Plane Measurement (Point Height)] window is closed without applying the setting contents.

## <7> [OK] button

By clicking, the [Plane (Point height)] window is closed, and the measurement result is applied in the grid sheet.

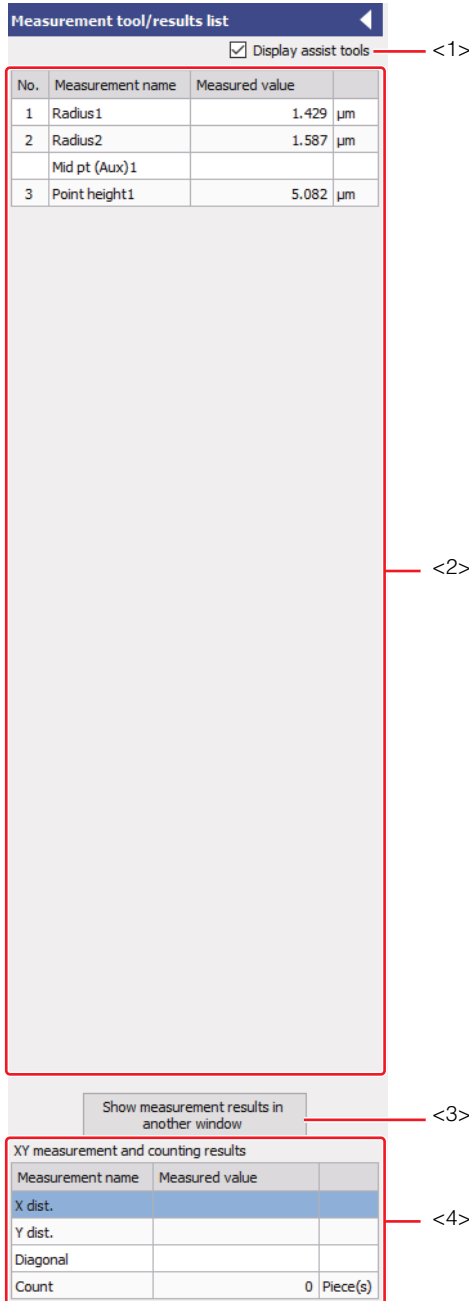
## <8> [Print/Save] button

Output the screen display contents in the following formats.

- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

## Measurement tool/results list

The measurement tool/results list displays the list of measurement tools used for plane measurement (point height) and the list of measurement results.



Click the button to collapse and hide the measurement tool/results list into the left edge of the window. Click the button to display it again.

### <1> [Display assist tools] checkbox

Selecting this checkbox displays the list of the assist tools in the measurement tool/results list.

### <2> Measurement tool/results list

Lists measurement names and measured values.

The element being selected in the measurement tool/results list or the image display area is highlighted in this list.



- A new element is added at the end.
- You can change the display order of elements by dragging them.



Element selection status is synchronized between the measurement tool/results list and the image display area. If you select an element in either area, it is selected and highlighted in both areas. Double-click the measurement name or change the name from the right-click menu.

### <3> [Show measurement results in another window] button

Displays the result displayed on the measured value in a different window. The displayed result can be saved as a text file in CSV format.

### <4> [XY measurement and counting results]

Displays the measured values of the following items as results of XY measurement.


Item	Description
X dist.	Real length between the vertical cursors.
Y dist.	Real length between the horizontal cursors.
Diagonal	Real length of a diagonal line of the rectangle surrounded by the horizontal and vertical cursors.
Count	The number of points placed on the image in the image display area.

# Plane Measurement (Point Height)

## Displaying the Plane Measurement (Point Height) Window















Displays the plane measurement (point height) window to perform measurement.

### 1 Open the measurement data or analysis result file.

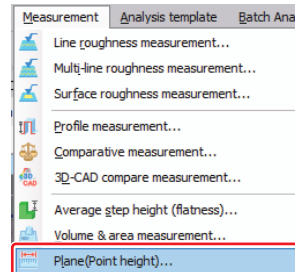
 Opening/Closing File (Page 3-2)



Perform the following preprocessing as needed.

- Reference Plane Settings
  -  Reference Plane Settings (Page 5-3)
- Leveling
  -  Leveling (Page 5-9)
- Surface shape correction
  -  Surface Shape Correction (Page 5-11)
- Inverting an Image
  -  Inverting an Image (Page 5-16)
- Smoothing
  -  Smoothing (Page 5-17)
- Height cut level
  -  Height Cut Level (Page 5-19)
- DCL/BCL
  -  DCL/BCL (Page 5-22)
- Missing data removal
  -  Missing Data Removal (Page 5-25)
- Noise removal
  -  Noise Removal (Page 5-26)
- Set invalid area
  -  Set invalid area (Page 5-28)
- Screen rotation
  -  Screen rotation (Page 5-29)
- Image trimming
  -  Image trimming (Page 5-30)
- C-DIC setting
  -  C-DIC setting (Page 5-32)
- Auto Position Adjustment
  -  Auto Position Alignment (Page 5-34)

### 2 Select [Plane (Point height)] from the [Measurement] menu. Or click the [Plane (Pt. height)] button on the toolbar.



The plane measurement (point height) window appears.

## Setting Measurement Line

Draw a measurement line at the measurement position on the image displayed in the plane measurement (point height) window. When the measurement line is set, the measured value at the measurement position is displayed.

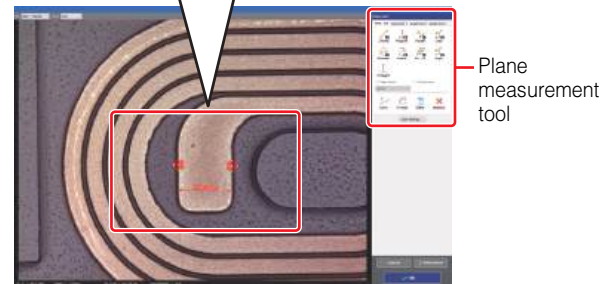
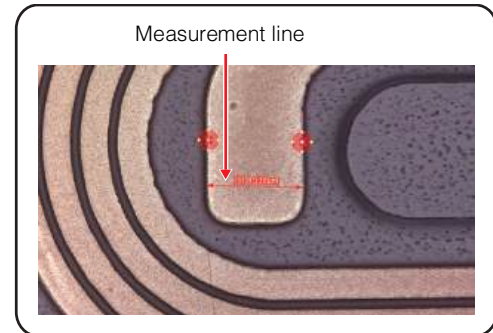
- 1 Select the [Assist tool 1] tab, [Assist tool 2] tab, or [Assist tool 3] tab in the plane measurement tool, and click the desired button to place an element on the image as needed.**

A measurement line consists of elements such as points and lines. If you place these elements on the measurement position in advance using the buttons on the [Assist tool 1] tab, [Assist tool 2] tab, or [Assist tool 3] tab, you can draw a measurement line accurately and efficiently in a way that is similar to actual drawing.

- 📖 What is an Element? (Page A-22)
- 📖 How to use assist tools (Page 6-25)

- 2 Click the desired button on the [Meas. tool] tab in the plane measurement tool and draw a measurement line on the image.**

📖 How to use measurement tool (Page A-55)



When the measurement line is drawn on the image, the measured value is displayed beside the measurement line.

Once you put the measurement line and confirm it, the measured values are updated in real time when you move the line. You can place the measurement line while confirming the measured value.

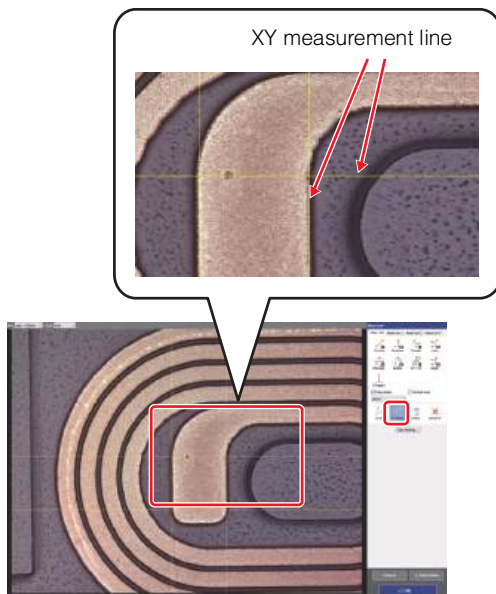
The measurement name and measured values are also displayed in the measurement tool/results list.

## Performing XY Measurement

Display horizontal and vertical cursors (XY measurement lines) on the image displayed in the image display area. Drag the XY measurement lines to measure [X dist.], [Y dist.], and [Diagonal] of the range surrounded by the lines.

### 1 Click the [XY meas] button in the plane measurement tool.

The XY measurement lines are displayed on the image.



### 2 Drag the XY measurement lines to specify the measurement place.

The [X dist.], [Y dist.], and [Diagonal] of the measurement place are displayed in the measurement tool/results list.

Because these measurement results are updated in real time while you are moving the XY measurement line, you can decide the place of the XY measurement line while confirming measurement results.

XY measurement and counting results	
Measurement name	Measured value
X dist.	4.435 $\mu\text{m}$
Y dist.	4.301 $\mu\text{m}$
Diagonal	6.178 $\mu\text{m}$
Count	0 Piece(s)

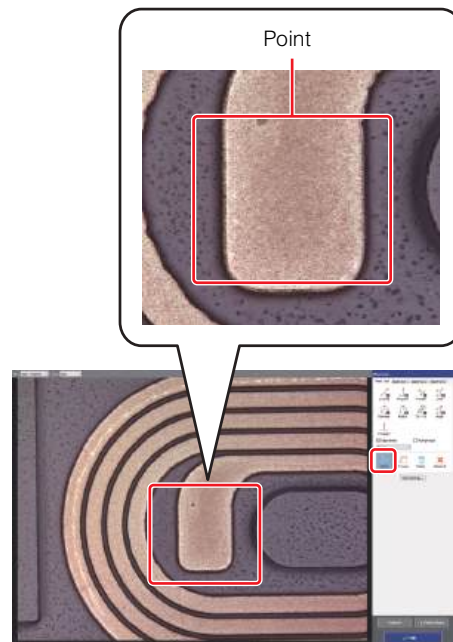
## Counting the Number of Points

With the [Count] button in the plane measurement tool, you can place up to 999 points on the image. The number of points placed is displayed in [Count] in the measurement tool/results list.

### 1 Click the [Count] button in the plane measurement tool.

### 2 Click arbitrary places on the image one by one to place points.

The x symbols appear at the placed points.



The number of points placed is displayed in [Count] in the measurement tool/results list.

XY measurement and counting results	
Measurement name	Measured value
X dist.	
Y dist.	
Diagonal	
Count	4 Piece(s)

## Applying the Measurement Result in the Main Screen

### 1 Click the [OK] button in the [Plane (Point height)] window.

The [Plane (Point height)] window is closed, and the measurement result is applied in the grid sheet.

**Reference** By clicking the [Cancel] button, the [Plane Measurement (Point Height)] window is closed without applying the setting contents.

## Operating the Grid View Area

Measurement data information and measurement analysis results are displayed on the grid view area. For setting the display contents, see the following.

- 📖 Grid view area (Page 2-8)
- 📖 Inserting items (Page 2-11)
- 📖 Sorting (Page 2-12)

## Exporting Measurement Result

Plane measurement (point height) results can be output to a report or Excel file.

### ● Report output

Outputs the results in a defined format in another window.

Refer to 📖 Report (Page 3-9).



### ● Exporting to Excel file

Outputs the image data and text to Excel in grid display layout.

Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to 📖 Exporting as Excel File (Page 3-15).

### ● Save CSV

Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

Refer to 📖 Exporting measurement result (Page 3-13).

# Plane measurement (auto measurement)

The "width" of the sample is automatically measured according to the detection conditions set beforehand for the profile graph of the measurement line (auto extract) arbitrarily specified on the image. It is available for measuring samples with regular patterns such as semiconductors and displays.

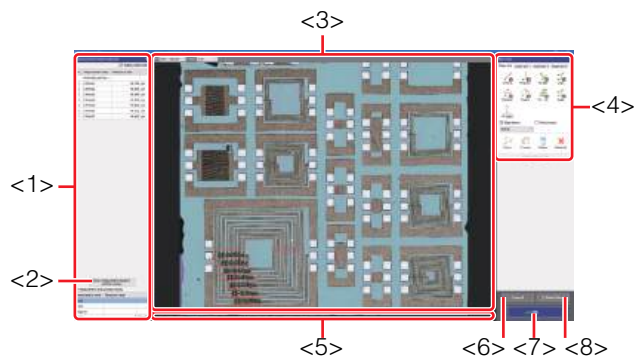
A single measurement line can measure the width of multiple locations simultaneously. In addition, by setting multiple measurement lines on the same image, the profile measurement can be made at multiple locations that are independent for each measurement line.



To perform auto measurement, use the image data measured by setting the measurement quality of the Viewer Application to something other than [High speed] or [Ultra high speed].  
In the case of image data measured by setting the measurement quality to [High speed] and [Ultra high speed], the data is interpolated to be displayed, which results in errors in the measurement values.

## Screen used for auto measurement

### ■ [Auto measurement] window



#### <1> Measurement tool/results list

Displays the list of measurement tools used for plane measurement (point height) and the list of measurement results.

☞ Measurement tool/results list (Page 7-4)

#### <2> [Show measurement results in another window] button

Displays the result displayed on the measured value in a different window. The displayed result can be saved as a text file in CSV format.

#### <3> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. You can set measurement lines on this image. You can also change the display type and magnification of the image.

#### <4> Plane tool

Contains buttons to draw various measurement lines, such as a straight line or a circle.

☞ Plane Measurement Tool (Page A-54)

#### <5> Status bar

The X and Y coordinates of the mouse placed on the image display area, and the height, RGB values and laser intensity at the coordinates are displayed.

#### <6> [Cancel] button

By clicking, the [Plane Measurement (Point Height)] window is closed without applying the setting contents.

#### <7> [OK] button

By clicking, the [Plane (Point height)] window is closed, and the measurement result is applied in the grid sheet.

#### <8> [Print/Save] button

Output the screen display contents in the following formats.

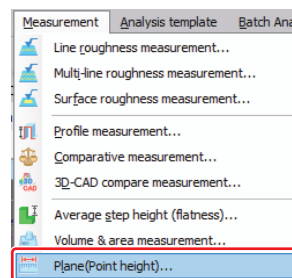
- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

## Displaying the [Auto measurement] window

### 1 Open the measurement data or analysis result file.

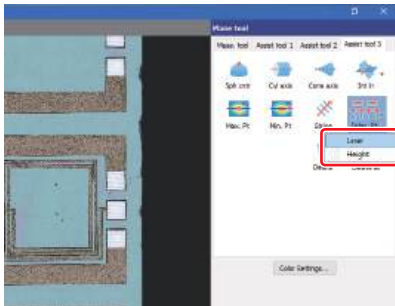
☞ Opening/Closing File (Page 3-2)

### 2 Select [Plane (Point height)] from the [Measurement] menu. Or click the [Plane (Pt. height)] button on the toolbar.



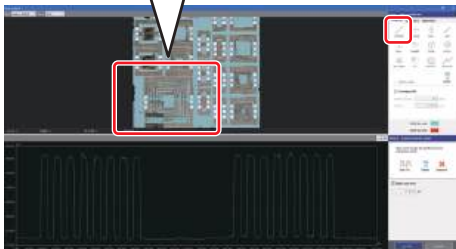
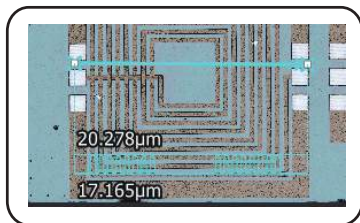
## Setting Measurement Line

- 1 Select the [Assist tool 3] tab in the plane measurement tool, and click the [Auto extract] button to place an element on the image.  
At that time, select the image to be measured from [Laser] or [Height].



The [Auto extract] window appears.

- 2 Click the [2 Points] button, and draw a measurement line on the image.  
A light reception intensity graph or a profile graph will appear in the [Auto extract] window, depending on [Laser] or [Height] selected in Step 1.



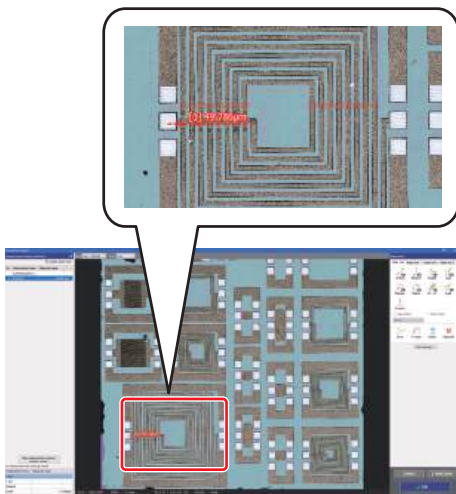
- 3 Click the [Inter. Pt.] button and set the threshold value on the graph.

The intersection point for the measurement is automatically extracted on the graph.





- 4 Click the [OK] button.  
The extracted intersection point is reflected in the image display area.

- 5** Click the [2 points] button on the [Measurement tool] tab in the plane measurement tool, and specify the extracted intersection points on the image and draw a measurement line. Alternatively, click the desired button, and specify the measurement place in combination with the measurement line and the extracted intersection points on the image.



When the measurement line is drawn on the image, the measured value is displayed beside the measurement line.

To measure multiple places, repeat Step 5.

 To perform the same measurement to multiple images, use  Batch Analysis (Page 16-1).

MEMO

# Average step (flatness)

This chapter describes the Average Step Height Measurement function found on the [Measurement] menu.

In the Average Step Height Measurement set the measurement area on the image, and measure the height difference, maximum height and minimum height of the reference area.

Flow of Average Step Height Measurement .... Page 8-2

Screen Used for Average Step Height Measurement ..... Page 8-3

Average Step Height Measurement ..... Page 8-7

# Flow of Average Step Height Measurement

The flow of Average Step Height Measurement is as follows:

## Setup

### Selecting measurement data

On the grid sheet, select the measurement data on which you want to perform average step height measurement.

Opening/Closing File (Page 3-2)

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Leveling
- Surface shape correction
- Inverting an image
- Smoothing
- Height cut level
- DCL/BCL
- Missing data removal
- Noise removal
- Set invalid area
- Screen rotation
- Image trimming
- C-DIC setting
- Auto Position Adjustment

Chapter 5, Measurement Preprocessing (Page 5-1)

## Measurement

### Displaying the average step height measurement window

Displays the Average Step Height Measurement window to perform measurement.

Displaying the Average Step Height Measurement Window (Page 8-7)

### Setting reference area

Set the reference area (an area as a reference for the measurement) image display area.

Setting Reference Area (Page 8-8)

### Setting measurement area

Specifies a measurement area in the image display area.

After the area is set, the measurement results will be displayed.

Setting Measurement Area (Page 8-8)

## Post-processing

### Exporting measurement result

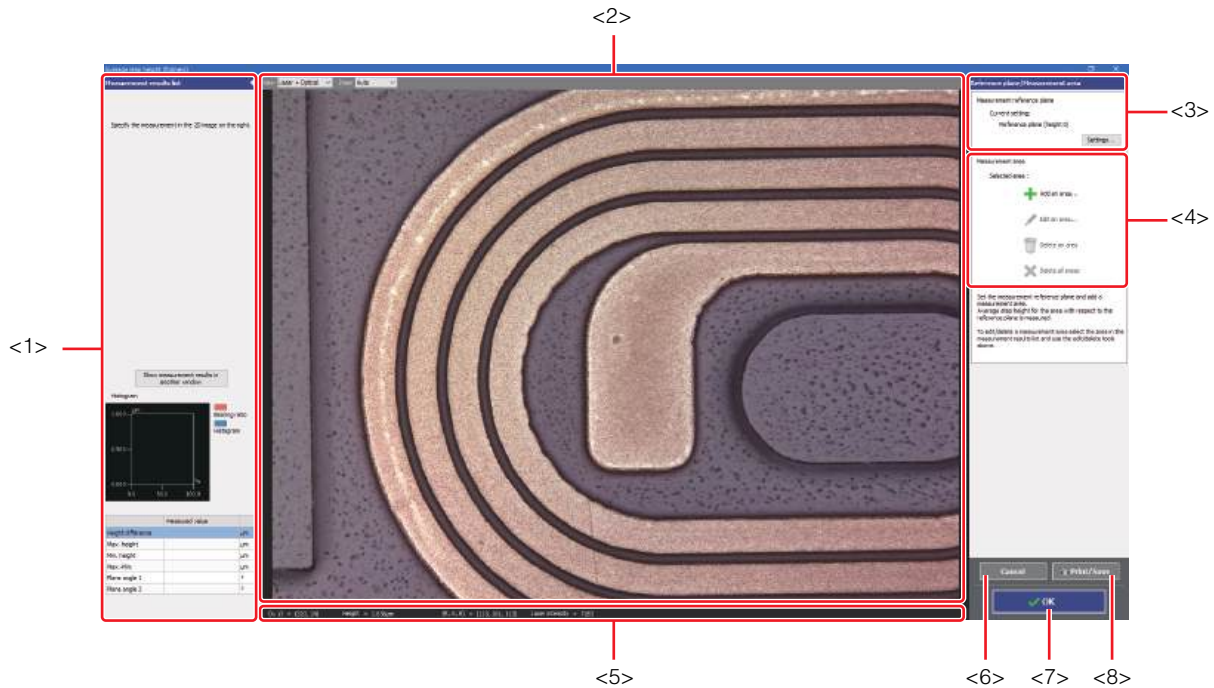
Output the measurement result to Excel file or create a report.

Exporting Measurement Result (Page 8-11)

# Screen Used for Average Step Height Measurement

Select [Average step height (flatness)] from the [Measurement] menu, or click the [Ave Step] button on the toolbar to display the average step height measurement window.

The following describes the name and functions of each part of the Average step height (flatness) window.




## <1> Measurement results list

Lists the measurement results obtained from the measurement area specified on the image.

📖 Measurement results list (Page 8-4)

## <2> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. You can also change the display type and magnification of the image.

 Changing the display type and the magnification of the image can be done using the [View] box and the [Zoom] box respectively displayed on the upper part of image display area.

## <3> Reference area setting tool

Set the reference area (measurement area as a reference for the measurement).

📖 Reference area setting tool (Page 8-5)

## <4> Measurement area settings tool

Adds, edits, and deletes the measurement area.

📖 Measurement Area Settings Tool (Page 8-5)

## <5> Status bar

The X and Y coordinates of the mouse placed on the image display area, and the height and RGB values and laser intensity at the coordinates are displayed.

## <6> [Cancel] button

By clicking, the [Average Step Height (flatness)] window is closed without applying the setting contents.

## <7> [OK] button

By clicking, the [Average step height (flatness)] window is closed, and the measurement result is applied in the grid sheet.

## <8> [Print/Save] button

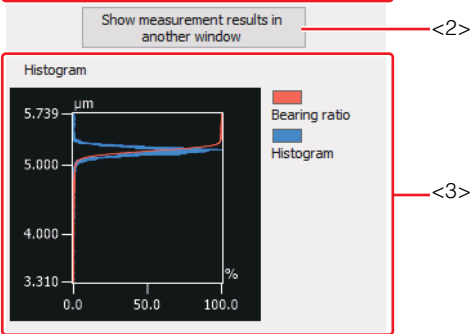
Output the screen display contents in the following formats.

- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

## Measurement results list

The measurement results list displays the list of the measurement results obtained from the measurement area specified on the image.

Color	Area	Height difference	Max. height
		μm	
	Total	17.774	19.
	Max.	7.463	8.
	Min.	5.112	5.
	Ave.	5.925	6.
	Std. DV	1.088	1.
	3 Sigma	3.265	3.
	Area1	7.463	8.
	Area2	5.112	5.
	Area3	5.198	5.



	Measured value	
Height difference	5.198	μm
Max. height	5.739	μm
Min. height	3.310	μm
Max.-Min.	2.429	μm
Plane angle 1	178.768	°
Plane angle 2	1.232	°

Reference

- You can move the separator between the measurement results list and the image display area to the right and left. You can enlarge the measurement results list to see all the measurement items at the same time. Or you can move the scroll bar under the measurement results list <1> to move the table columns displayed.
- Click the button to collapse and hide the measurement results list into the left edge of the window. Click the button to display the measurement results list again.

### <1> Measurement results list

Displays area names and a list of measured values for each area.

The currently selected area is highlighted.

Also, the following items and the measured value list are also displayed for all areas.

Item	Description
Height difference	Average height of an area (height relative to reference plane). Points lower than the reference plane will have negative values.
Max. height	Maximum height of an area (height relative to reference plane).
Min. height	Minimum height of an area (height relative to reference plane).
Max.-Min.	Difference between maximum height and minimum height.
Plane angle 1, 2	The angle for the reference plane/ measurement area. The plane angle 1 is the angle between the two planes (0 to 180 degrees), and the plane angle 2 is a supplementary angle of the plane angle 1 (180 - plane angle 1). When the two specified planes are to be parallel, the plane angle 1 becomes 180 degrees.

Item	Description
Total	Total value from the entire area.
Max.	Maximum value in the area.
Min.	Minimum value in the area.
Ave.	Average value in the area.
Std. DV	Variations in data
3 Sigma	Variations in data

### <2> [Show measurement results in another window] button

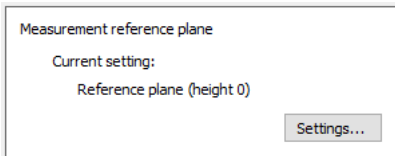
Displays the result displayed on the measured value in a different window. The displayed result can be saved as a text file in CSV format.

### <3> Histogram

Displays the height distribution data.

## Reference area setting tool

Set the reference area in the reference area setting tool.

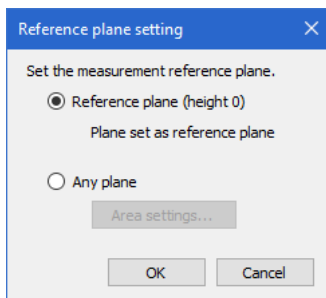


[Settings] button

Clicking on this button displays the [Reference plane setting] window.

After setting the reference area in the [Reference plane setting] window and click the [OK] button, the reference area will be set up.

## Reference plane setting dialog box



[Reference plane (height 0)] radio button

The plane set in the reference settings for image processing is used as reference area.

Reference Plane Settings (Page 5-3)

[Any plane] radio button

Click the [Area Settings] button and specify a reference area.

For further information on the area setting procedures, refer to Area Settings (Page A-2).

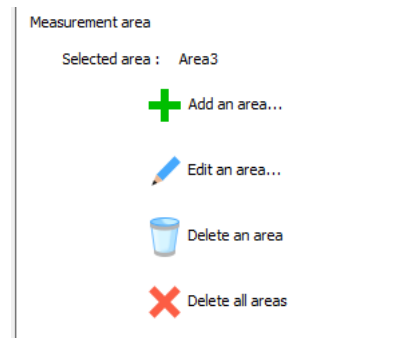
Point

Use the reference plane and any plane separately.

- It is convenient to use the reference plane to compare the place and step height specified in reference plane settings.
- The "Any plane" can calculate the flatness of an arbitrary plane you select, and the flatness between arbitrary planes.

## Measurement Area Settings Tool

Add, edit, and delete the measurement area in the measurement area setting tool.



[Add an area...] button

Clicking on this button displays the [Area settings] window.

After setting the area in the [Area settings] window and click the [OK] button, the area will be added to the image display area.

[Edit an area...] button

Clicking on this button displays the [Area settings] window.

When you edit an area in the [Area settings] window, the area displayed in the image display area and the measured values in the measurement results list will be updated.

[Delete an area] button

Deletes the selected area.

[Delete all areas] button

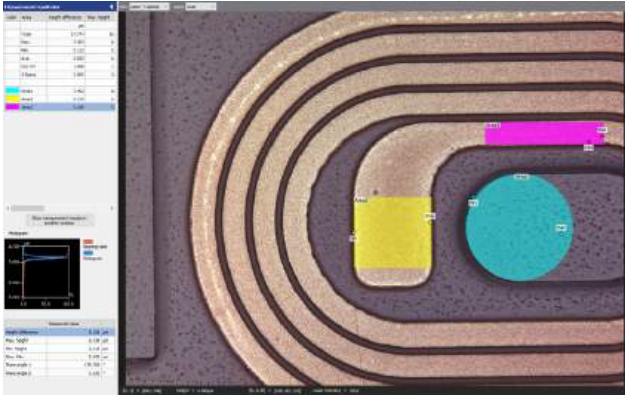
Deletes all the areas that have been set on the image display area.

Point

To restore a deleted area, press the "Ctrl+Z" keys on the keyboard.

## Displaying measurement results

When you set an area, measurement results are displayed in the measurement results list.



**Reference**

- You can change the order of the rows in the table by dragging an area name.
- You can change the area rendering color by clicking the color palette of [Color].
- You can change an area name by clicking the area name of the selected area or selecting [Rename] from the right-click menu.

The following items and the measured value list are displayed for all the areas.

# Average Step Height Measurement

## Displaying the Average Step Height Measurement Window

Displays the Average Step Height Measurement window to perform measurement.

### 1 Open the measurement data or analysis result file.

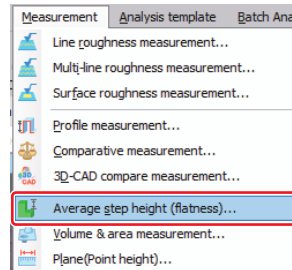
📖 Opening/Closing File (Page 3-2)



Perform the following preprocessing as needed.

- Reference Plane Settings
  - 📖 Reference Plane Settings (Page 5-3)
- Leveling
  - 📖 Leveling (Page 5-9)
- Surface shape correction
  - 📖 Surface Shape Correction (Page 5-11)
- Inverting an Image
  - 📖 Inverting an Image (Page 5-16)
- Smoothing
  - 📖 Smoothing (Page 5-17)
- Height cut level
  - 📖 Height Cut Level (Page 5-19)
- DCL/BCL
  - 📖 DCL/BCL (Page 5-22)
- Missing data removal
  - 📖 Missing Data Removal (Page 5-25)
- Noise removal
  - 📖 Noise Removal (Page 5-26)
- Set invalid area
  - 📖 Set invalid area (Page 5-28)
- Screen rotation
  - 📖 Screen rotation (Page 5-29)
- Image trimming
  - 📖 Image trimming (Page 5-30)
- C-DIC setting
  - 📖 C-DIC setting (Page 5-32)
- Auto Position Adjustment
  - 📖 Auto Position Alignment (Page 5-34)

### 2 Select [Average step height (flatness)] from the [Measurement] menu. Or click the [Ave step] button on the toolbar.

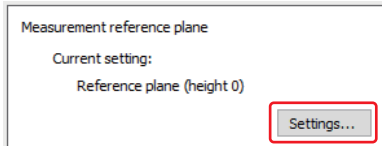


The average step height measurement window appears.

## Setting Reference Area

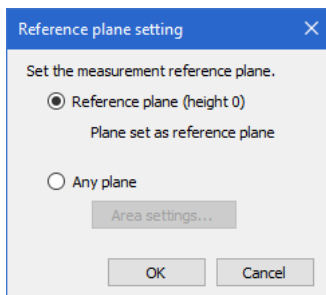
To compare the measurement area, the reference area is set up.

### 1 Click the [Settings] button.



The [Reference plane setting] dialog box appears.

### 2 Select a method to specify the reference area through radio button.



### 3 Click the [OK] button.

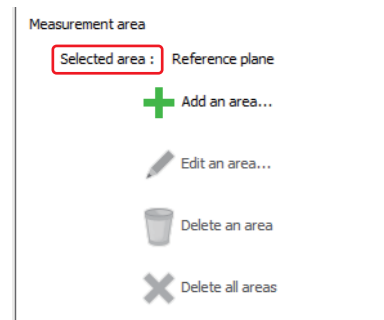
The reference area is set up.

## Setting Measurement Area

Draw a measurement area at the measurement position on the image displayed in the average step height (flatness) window.

When you set them, measured values in the area are displayed in the measurement results list.

Also, the points with the maximum and minimum height on the area you set are indicated as " $\Delta_{\max}$ " or " $\nabla_{\min}$ ".

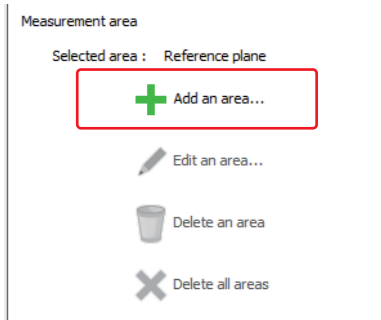


! Point

- By default where no area is set yet, buttons other than the [Add an area] button cannot be clicked. When more than one area are selected, buttons other than the [Add an area] and [Delete all areas] buttons cannot be clicked.
- When you edit or delete an area, make sure the target area name is displayed in [Selected area].

## Adding measurement area

### 1 Click the [Add an area...] button.

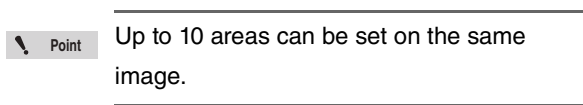


The [Area settings] window appears.

### 2 Set an area, and click the [OK] button.

The area is set in the image display area.

For further information on the area setting procedures, refer to Area Settings (Page A-2).



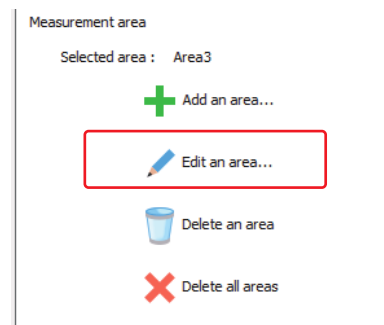
## Editing measurement area

### 1 Select a desired area from the measurement results list.

Measurement results list			
Color	Area	Height difference	Max. height
		$\mu\text{m}$	
	Total	17.774	19.
	Max.	7.463	8.
	Min.	5.112	5.
	Ave.	5.925	6.
	Std. DV	1.088	1.
	3 Sigma	3.265	3.
	Area1	7.463	8.
	Area2	5.112	5.
	Area3	5.198	5.

The name of the selected area is displayed in [Selected area].

### 2 Click the [Edit an area...] button.



The [Area settings] window appears.

### 3 Edit an area, and click the [OK] button.

The area displayed in the image display area and the measured values in the measurement results list are updated.

For further information on the area setting procedures, refer to Area Settings (Page A-2).

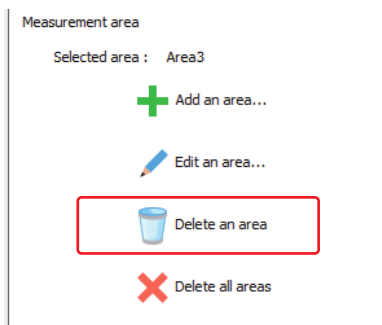
## Deleting measurement area

- 1 Select a desired area from the measurement results list.

Measurement results list			
Color	Area	Height difference	Max. height
		μm	
	Total	17.774	19.
	Max.	7.463	8.
	Min.	5.112	5.
	Ave.	5.925	6.
	Std. DV	1.088	1.
	3 Sigma	3.265	3.
	Area1	7.463	8.
	Area2	5.112	5.
	Area3	5.198	5.

The name of the selected area is displayed in [Selected area].

- 2 Click the [Delete an area] button.



The target area is deleted from the image display area.  
The row of the target area is also deleted from the measurement results list.

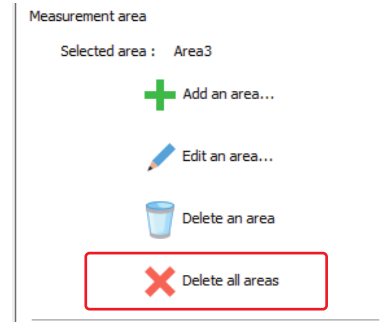


When the target area is selected on the measurement results list, you can also delete the area by doing either of the following.

- Press the Delete key.
- Select [Delete] from the right-click menu.

## Deleting all areas

- 1 Click the [Delete all areas] button.



All the areas that have been set are deleted from the image display area.

## Applying the Measurement Result in the Main Screen

### 1 Click the [OK] button in the [Average step height (flatness)] window.

The [Average step height (flatness)] window is closed, and the measurement result is applied in the grid sheet.



By clicking the [Cancel] button, the [Average step height (flatness)] window is closed without applying the setting contents.

## Operating the Grid View Area

Measurement data information and measurement analysis results are displayed on the grid view area. For setting the display contents, see the following.

- Grid view area (Page 2-8)
- Inserting items (Page 2-11)
- Sorting (Page 2-12)

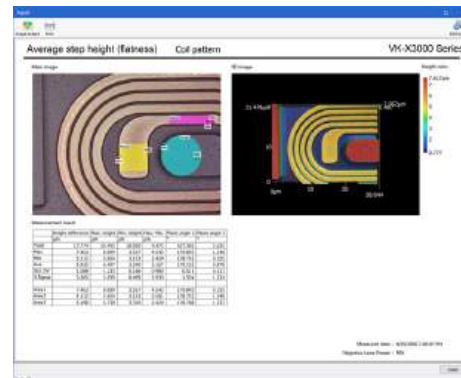
## Exporting Measurement Result

Average step height measurement results can be output to a report or Excel file.

### ● Report output

Outputs the results in a defined format in another window.

Refer to Report (Page 3-9).



### ● Exporting to Excel file

Outputs the image data and text to Excel in grid display layout.

Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to Exporting as Excel File (Page 3-15).

### ● Save CSV

Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

Refer to Exporting measurement result (Page 3-13).

MEMO

# Volume & Area Measurement

This chapter describes the volume & area measurement function found on the [Measurement] menu.

The volume & area measurement function measures "volume", "surface area", etc. of a measurement area arbitrarily specified on the image.

You can also set a plane parallel to the reference plane as a "height threshold", separate areas that are higher (convex) or lower (concave) than the plane specified with the height threshold value, and measure volume, surface area, height, etc. of each area.

Flow of Volume & Area Measurement ..... Page 9-2

Screen Used for Volume & Area Measurement .. Page 9-3

Volume & Area Measurement ..... Page 9-8

# Flow of Volume & Area Measurement

The flow of volume & area measurement is as follows:

## Setup

### Selecting measurement data

On the grid sheet, select the measurement data on which you want to perform volume & area measurement.

Opening/Closing File (Page 3-2)

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Leveling
- Surface shape correction
- Inverting an image
- Smoothing
- Height cut level
- DCL/BCL
- Missing data removal
- Noise removal
- Set invalid area
- Screen rotation
- Image trimming
- C-DIC setting
- Auto Position Adjustment

Chapter 5, Measurement Preprocessing (Page 5-1)

## Measurement

### Displaying the volume & area measurement window

Display the volume & area measurement window to perform measurement.

Displaying the Volume & Area Measurement Window (Page 9-8)

### Setting measurement area

Set an area on the image displayed in the volume & area measurement window.

When you set an area, measured values of the measurement target area in the area are displayed.

Setting an Area (Page 9-9)

### Setting the height threshold value

Set a height threshold to determine convex and concave areas of the sample.

Setting the Height Threshold Value (Page 9-11)

## Post-processing

### Exporting measurement result

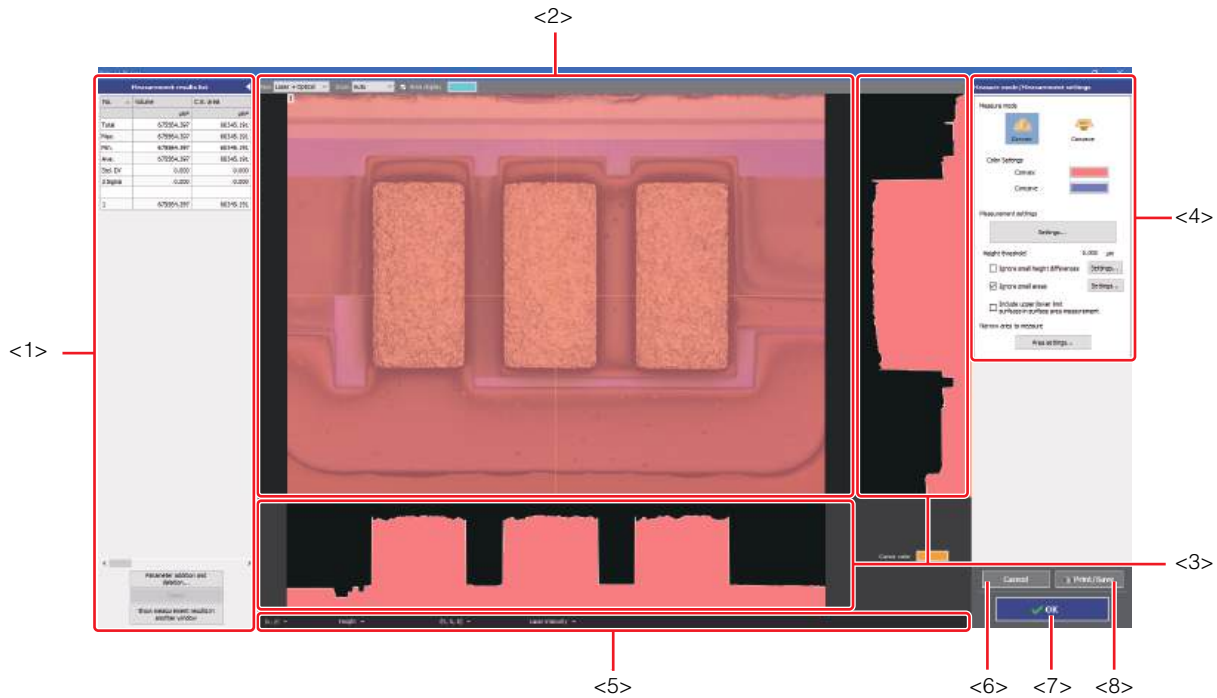
Output the measurement result to Excel file or create a report.

Exporting Measurement Result (Page 9-12)

# Screen Used for Volume & Area Measurement

Select [Volume & area measurement] from the [Measurement] menu, or click the [Vol & area] button on the toolbar to display the volume & area measurement window.

The following describes the name and functions of each part of the volume & area measurement window.



## <1> Measurement results list

Lists the measurement results obtained from the measurement area specified on the image.

Measurement results list (Page 9-4)

## <2> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. You can also change the display type and magnification of the image.

Changing the display type and the magnification of the image can be done using the [View] box and the [Zoom] box respectively displayed on the upper part of image display area.

## <3> Profile display area

Displays the cross section profile of the sample which is cut perpendicularly to the reference plane at the cursor position in vertical and horizontal directions on the image.

## <4> Measurement settings tool

Contains setting tools to perform measurements, such as the button to switch measurement modes, the button to set an area, etc.

Measurement Settings Tool (Page 9-6)

## <5> Status bar

The X and Y coordinates of the mouse placed on the image display area, and the height, RGB values and laser intensity at the coordinates are displayed.

## <6> [Cancel] button

By clicking, the [Volume & Area Measurement] window is closed without applying the setting contents.

## <7> [OK] button

By clicking, the [Volume & Area Measurement] window is closed, and the measurement result is applied in the grid sheet.

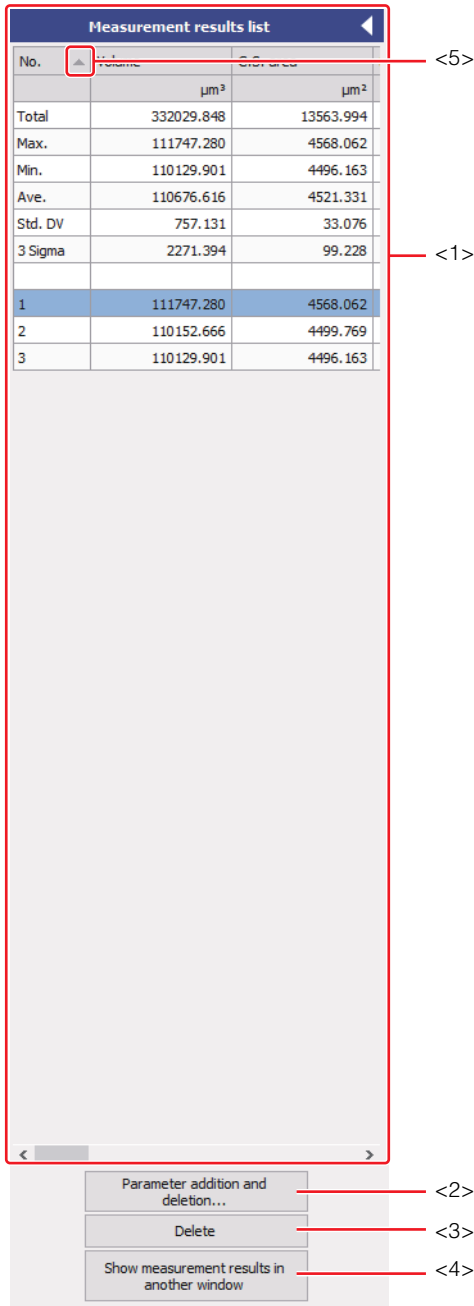
## <8> [Print/Save] button

Output the screen display contents in the following formats.

- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

## Measurement results list

The measurement results list displays the list of the measurement results obtained from the area specified on the image.



Reference

- You can move the separator between the measurement results list and the image display area to the right and left. You can enlarge the measurement results list to see all the measurement items at the same time. Or you can move the scroll bar under the measurement results list <1> to move the table columns displayed.
- Click the button to collapse and hide the measurement results list into the left edge of the window. Click the button to display it again.

### <1> Measurement results list

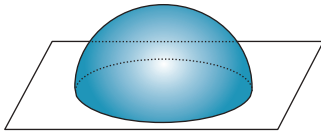
Lists the following measurement items and measured values by measurement target areas. The currently selected measurement target area is highlighted.

Item	Description
Volume	Volume of the part surrounded by the surface of the measurement target and the plane specified with the height threshold value.
C.S. area	Cross-sectional area of the surface of the measurement target cut by the plane specified with the height threshold value.
Surface area	Surface area of the part surrounded by the surface of the measurement target and the plane specified with the height threshold value. This value depends on the on/off status of the [Include upper/lower limit surfaces in surface area measurement] checkbox. When the checkbox is off, this value consists of only the curved surface of the shape data, while the checkbox is on, it also includes the cross-section cut by the plane specified with the height threshold value.
Surface area/C.S. area	Surface area of the measurement target divided by the cross-sectional area.
Area ratio	Cross-sectional area/Area of the entire area.
Average height	Average height of the measurement target (average depth when it is a measurement of a concave part). This is the average value between heights of the shapes in the measurement target area, from the plane specified with the height threshold value.
Max. height	Maximum height of the measurement target (maximum depth when it is a measurement of a concave part). This is the maximum value between heights of the shapes in the measurement target area, from the plane specified with the height threshold value.
Perimeter	Contour line length of the cross-sectional area of the shape cut by the plane specified with the height threshold value.
Horz. Feret (Horizontal feret diameter)	Length in the X direction of the cross-section of the shape cut by the plane specified with the height threshold value.
Vert. Feret (Vertical feret diameter)	Length in the Y direction of the cross-section of the shape cut by the plane specified with the height threshold value.
Circle equivalent dia	Diameter of a circle that has the same area as the cross-sectional area.

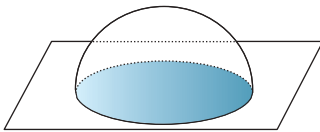
Item	Description
Circularity	Indicates how close the object is to a true circle. Circularity of the cross-section is defined by $4\pi$ multiplied by the cross-section area and divided by the perimeter <sup>2</sup> , and when the measurement target is a true circle, the value is 1. Circularity is calculated by the cross-sectional area with hole(s).
Sphere diam	Diameter of a sphere when the measurement target shape is considered as a sphere.

The processing image of each measurement item is shown below using a hemispherical measurement target and the plane specified with a height threshold value.

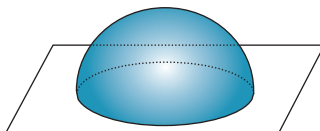
- Volume



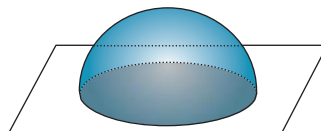
- C. S. area



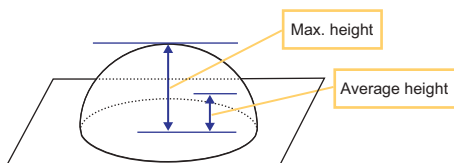
- Surface area ([Include upper, lower limit surfaces in surface area measurement] checkbox ON)



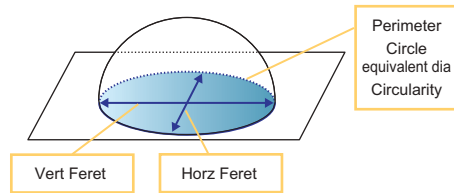
- Surface area ([Include upper, lower limit surfaces in surface area measurement] checkbox OFF)



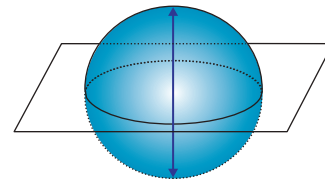
- Average height, Max. height




- Perimeter, Circle equivalent dia, Circularity, Horz Feret, Vert Feret



- Sphere diam



<5> Click the  button to toggle the display order of the measurement target area between ascending and descending.

Also, the following items and the measured value list are also displayed for all the measurement target areas.

Item	Description
Total	Total value from the entire measurement target area.
Max.	Maximum value in the measurement target area.
Min.	Minimum value in the measurement target area.
Ave.	Average value in the measurement target area.
Std. DV	Variations in data
3 Sigma	Variations in data



When you select a measurement target area in the measurement results list, the area in the image display area is displayed in the specified cursor color.

**<2> [Parameter addition and deletion] button**

Sets whether to show or hide the roughness parameter displayed on the measured value.

**<3> [Delete] button**

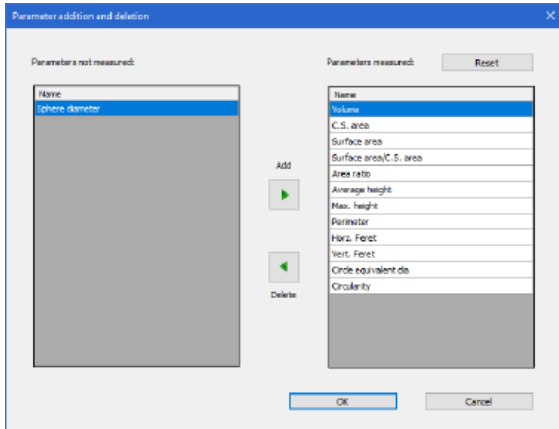
Deletes the selected measurement target area.

**<4> [Show measurement results in another window] button**

Displays the result displayed on the measured value in a different window. The displayed result can be saved as a text file in CSV format.

## Parameter addition and deletion dialog box

Displays frequently used parameters in the measurement results list.



### Parameters not measured

Parameters not displayed on the measurement result list.  
Click while pressing Ctrl or Shift to select multiple data.

### Parameters measured

Parameters displayed on the measurement result list.

#### [Reset] button

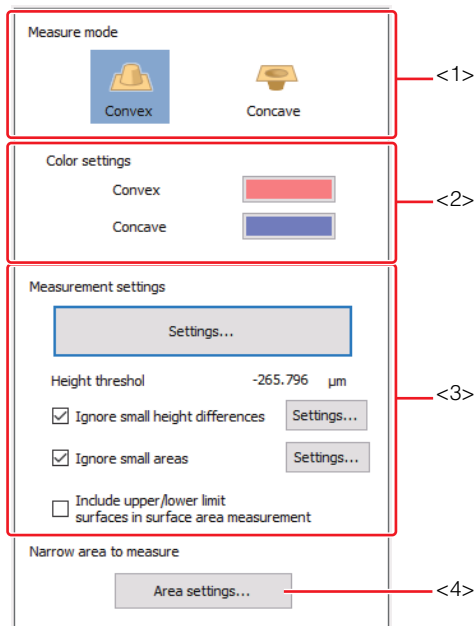
Resets the displayed parameter settings.

#### [Add]/[Delete] button

Adds or deletes the selected parameter.

## Measurement Settings Tool

Use the measurement settings tool to configure settings for volume & area measurement.



### <1> [Measure mode]

Select which of convex part and concave part of the sample to measure.

### <2> [Color settings]

Select display colors for [Convex], and [Concave] from the color palette.

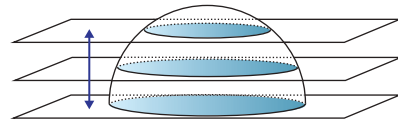
### <3> [Measurement settings]

Set the height threshold for volume & area measurement. Select also options used for calculating measured values.

#### [Settings] button

Click to display the [Set threshold] dialog box, and set the height threshold.

- Height threshold value setting

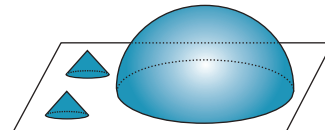


#### [Ignore small height differences] checkbox

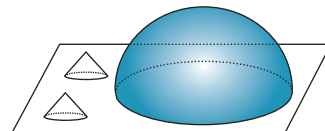
Select whether to include small unevennesses (areas smaller or equal to the specified lower limit) in the measurement target areas or not.

When this is selected, small unevennesses are excluded from measurement target areas.

- [Ignore small height differences] checkbox OFF



- [Ignore small height differences] checkbox ON

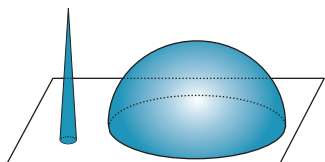


**[Ignore small areas] checkbox**

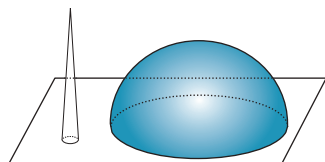
Specify whether to include small areas (areas smaller or equal to the specified lower limit) in the measurement target areas or not.

When this is selected, small areas are excluded from measurement target areas. Click [Settings] and set a minimum height for the measurement target area.

- [Ignore small areas] checkbox OFF



- [Ignore small areas] checkbox ON



# Volume & Area Measurement

## Displaying the Volume & Area Measurement Window

Display the volume & area measurement window to perform measurement.

### 1 Open the measurement data or analysis result file.

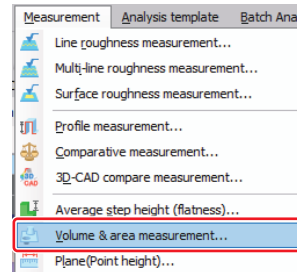
Opening/Closing File (Page 3-2)



Perform the following preprocessing as needed.

- Reference Plane Settings
  - Opening/Reference Plane Settings (Page 5-3)
- Leveling
  - Opening/Leveling (Page 5-9)
- Surface shape correction
  - Opening/Surface Shape Correction (Page 5-11)
- Inverting an Image
  - Opening/Inverting an Image (Page 5-16)
- Smoothing
  - Opening/Smoothing (Page 5-17)
- Height cut level
  - Opening/Height Cut Level (Page 5-19)
- DCL/BCL
  - Opening/DCL/BCL (Page 5-22)
- Missing data removal
  - Opening/Missing Data Removal (Page 5-25)
- Noise removal
  - Opening/Noise Removal (Page 5-26)
- Set invalid area
  - Opening/Set invalid area (Page 5-28)
- Screen rotation
  - Opening/Screen rotation (Page 5-29)
- Image trimming
  - Opening/Image trimming (Page 5-30)
- C-DIC setting
  - Opening/C-DIC setting (Page 5-32)
- Auto Position Adjustment
  - Opening/Auto Position Alignment (Page 5-34)

### 2 Select [Volume & area measurement] from the [Measurement] menu. Or click the [Vol & area] button on the toolbar.



The volume & area measurement window appears.

## Setting an Area

Set an area on the image displayed in the volume & area measurement window.

When you set an area, measured values of the measurement target area in the area are displayed in the measurement result list.

**Reference** By default, the entire image is set as the area.

- 1 Click the [Area settings] button in the measurement settings tool.



The [Area settings] window appears.

- 2 Click the desired area setting button (<1>) to set an area on the image.

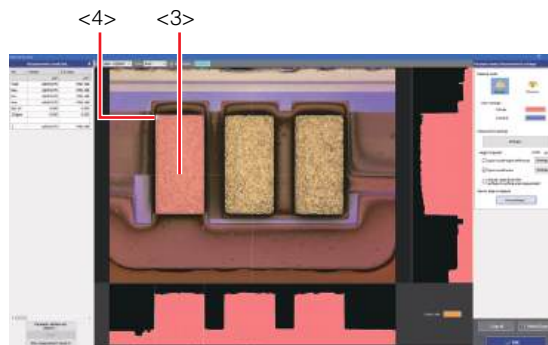
**Area Settings (Page A-2)**



The set area is painted in the area rendering color.

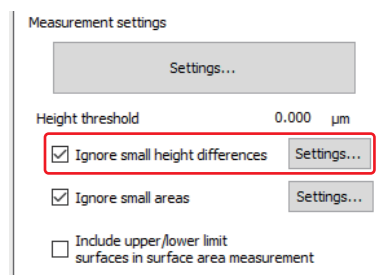
- 3 When you finished setting areas, click the [OK] button (<2>) in the [Area settings] window.

The [Area settings] window is closed and the volume & area measurement window returns.



When you set an area (<3>) on the image, label numbers are assigned to the measurement target areas (convex or concave closed areas) (<4>) in the area, and convex parts and concave parts are displayed in the specified rendering color. Also, the measured values of the measurement target areas are displayed in the measurement results list.

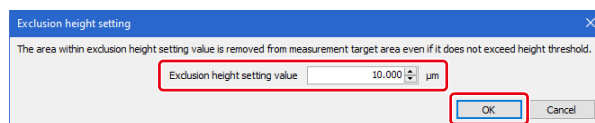
- 4 As needed, select the [Ignore small height differences] checkbox and click the [Settings] button.



The [Exclusion height setting] dialog box appears.

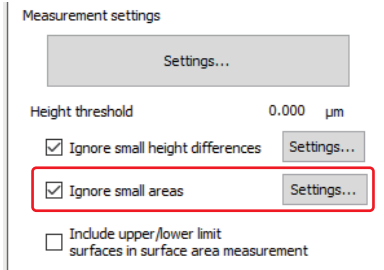
- 5 If you select the [Ignore small height differences] checkbox, enter the lower limit for height in the [Exclusion height setting value] box, and click the [OK] button.

When the lower limit is set, areas of which height is less than or equal to the lower limit are excluded from the measurement target areas.



**Reference** As for the default value, the value is set automatically.

**6** As needed, select the [Ignore small areas] checkbox and click the [Settings...] button.

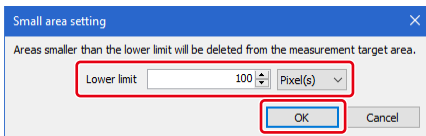


The [Small area setting] dialog box appears.

**7** If you select the [Ignore small areas] checkbox, enter the lower limit for measurement target areas in the [Lower limit] box, and click the [OK] button.

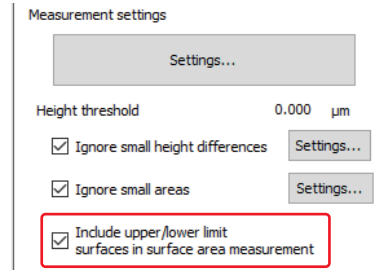
When the lower limit is set, areas less than or equal to the lower limit are excluded from the measurement target areas.

You can select the unit for the lower limit value from [pixel] or [mm<sup>2</sup>], [μm<sup>2</sup>], or [nm<sup>2</sup>].



**Reference** By default, the lower limit is 100 pixel.

**8** Select the [Include upper/lower limit surfaces in surface area measurement] checkbox as needed.



Depending on the ON/OFF status for this checkbox, the value of surface area in measurement results is calculated as follows.

OFF: Surface area that does not include the area of the surfaces at the upper and lower limits (a)

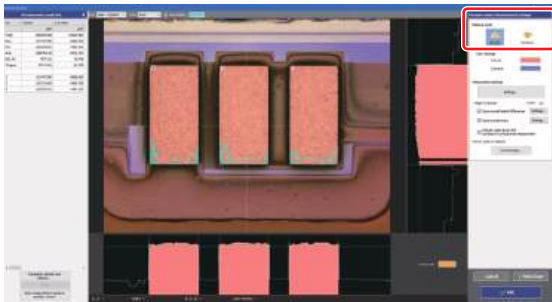
ON: Surface area that includes the area of the surfaces at the upper and lower limits = (a) + cross-sectional area (area of the cross-section obtained when the object is cut by the plane specified with the height threshold value.)

**Reference** The setting for [Include upper/lower limit surfaces in surface area measurement] checkbox does not influence the measurement area.

## Setting the Height Threshold Value

Set a height threshold to determine convex and concave areas of the sample. The default setting of the height threshold value is set to zero (0), equal to the height of the reference plane. The higher areas than the plane specified with height threshold value are convex, and the lower areas are concave.

- 1 Click the **[Convex]** or **[Concave]** button in the measurement settings tool.



### **[Convex] button**

Use this to perform convex measurement.

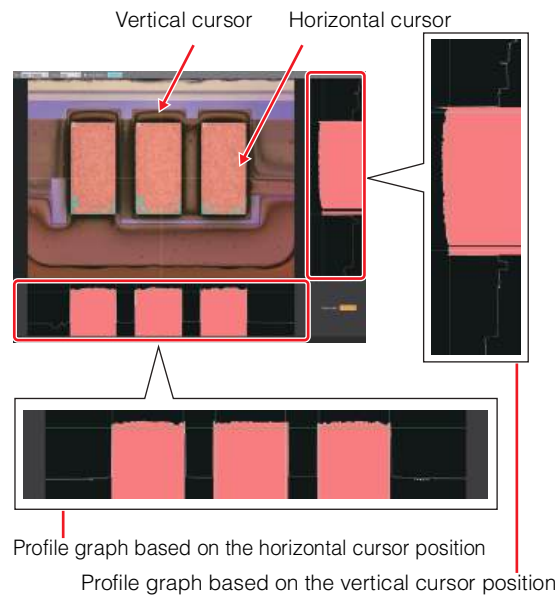
### **[Concave] button**

Use this to perform concave measurement.

- 2 Drag the vertical and horizontal cursors on the image display area to the area you want to measure.

Profile graphs in the vertical and horizontal directions are displayed in the profile display areas.

The profile graphs are updated in real-time when the cursor is moved and thus, you can determine the measurement position while checking the waveform.



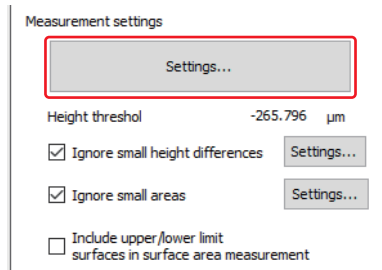
- 3 Drag the reference line of profile graph and set the height threshold.





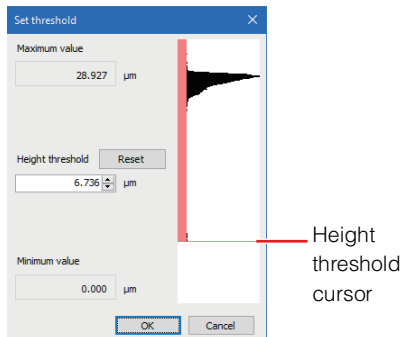
The height threshold can also be set in the [Set threshold] dialog box.

To open the [Set threshold] dialog box, click the [Settings] button of the height threshold in the [Measurement settings] in the measurement settings tool.



In the [Set threshold] dialog box, click the [Reset] button, or enter a value manually to set the height threshold.

The threshold can also be set by dragging the height threshold cursor in the histogram below.



## Applying the Measurement Result in the Main Screen

- 1 Click the [OK] button in the [Volume & Area Measurement] window.

The [Volume & Area Measurement] window is closed, and the measurement result is applied in the grid sheet.



By clicking the [Cancel] button, the [Volume & Area Measurement] window is closed without applying the setting contents.

## Operating the Grid View Area

Measurement data information and measurement analysis results, and number of measurement are displayed on the grid view area. For setting the display contents, see the following.

- Grid view area (Page 2-8)
- Inserting items (Page 2-11)
- Sorting (Page 2-12)

## Exporting Measurement Result

The measurement results of the volume & area measurement can be output to a report or Excel file.

### ● Report output

Outputs the results in a defined format in another window.

Refer to Report (Page 3-9).



### ● Exporting to Excel file

Outputs the image data and text to Excel in grid display layout.

Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to Exporting as Excel File (Page 3-15).

### ● Save CSV

Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

Refer to Exporting measurement result (Page 3-13).

# Chapter 10

## Line Roughness Measurement

This chapter describes the line roughness measurement function found on the [Measurement] menu.

This measurement measures the line roughness of the sample for the profile graph of any profile line (straight line/curve) specified on the image. In addition, line roughness for each of the profile lines which are independent of each other can be measured after drawing multiple profile lines on the same image.

Flow of Line Roughness Measurements ...	Page 10-2
Line Roughness Measurements Window ....	Page 10-3
Line Roughness Measurement .....	Page 10-6
Roughness Definitions .....	Page 10-14

# Flow of Line Roughness Measurements

The flow of line roughness measurements is as follows:

## Setup

### Selecting measurement data

- On the grid sheet, select the measurement data on which you want to perform line roughness measurement.

📖 Opening/Closing File (Page 3-2)

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Leveling
- Surface shape correction
- Inverting an image
- Smoothing
- Height cut level
- DCL/BCL
- Missing data removal
- Noise removal
- Set invalid area
- Screen rotation
- Image trimming
- C-DIC setting
- Auto Position Adjustment

📖 Chapter 5, Measurement Preprocessing (Page 5-1)

## Measurement

### Displaying the line roughness measurement window

- Display the line roughness measurement window to perform measurement.

📖 Displaying the Line Roughness Measurement Window (Page 10-6)

### Setting profile line

- Draw a profile line at the measurement position on the image displayed in the line roughness measurement window. When the profile line is drawn on the image, the total profile at the measurement position and measurement result are displayed.

📖 Setting Profile Line (Page 10-7)

### Setting measurement type

- Specify the measurement type (Roughness, Primary, Waviness).

📖 Changing the Measurement Type (Page 10-8)

### Setting cutoff value

- Set a cutoff value.

📖 Setting a Cutoff Value (Page 10-8)

### Setting Filter

- Set the filter to ON/OFF as needed.

📖 Setting Filter (Page 10-9)

### Correcting total profile

- As needed, perform a correction to correct the laser intensity level cut and the tilt of the total profile.

📖 Correcting the DCL/BCL (Page 10-9)

📖 Correcting the Tilt of Total Profile (Page 10-10)

### Line roughness measurement detail settings

- When measuring the following parameters, set the threshold values for dead zone width, cut level, etc.

- Peak count
- High spot count
- Cut level difference
- Relative load length ratio
- Load length ratio

📖 Line roughness measurement detail settings (Page 10-11)

### Setting Evaluation Length

- As needed, set segments on the total profile graph, and obtain values for each segment.

📖 Setting Evaluation Length (Page 10-12)

## Post-processing

### Exporting measurement result

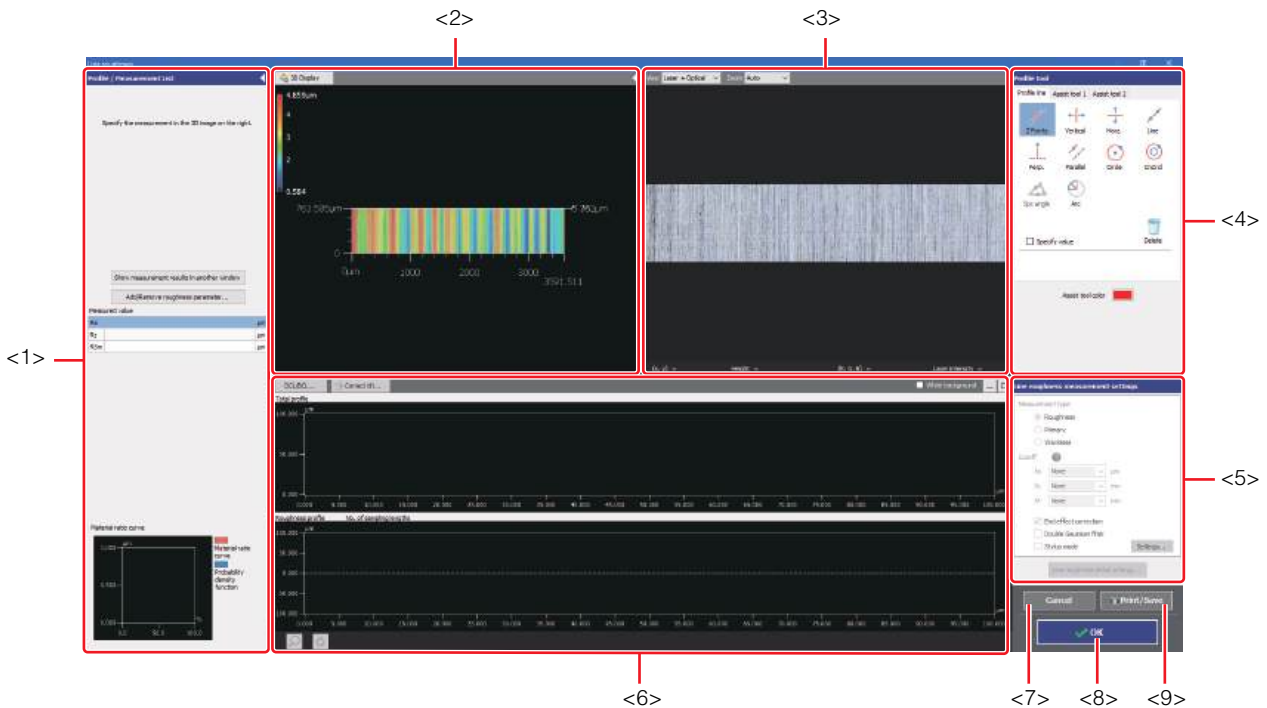
- Output the measurement result to Excel file or create a report.

📖 Exporting Measurement Result (Page 10-13)

# Line Roughness Measurements Window

Select [Line roughness] from the [Measurement] menu, or click the [Line R] button on the toolbar to display the line roughness measurement window.

The following describes the name and functions of each part of the line roughness measurement window.



## <1> Profile/Measurement list

Lists profiles and elements placed on the image, and measurement results.

📖 Profile/Measurement List (Page 10-4)


## <2> 3D display area

Displays a stereoscopic shape of the sample and the cross section of the selected profile.

📖 Configuring Image Display (Page 4-4)

## <3> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. You can set a profile line on this image. You can also change the display type and magnification of the image.

 Changing the display type and the magnification of the image can be done using the [View] box and the [Zoom] box respectively displayed on the upper part of image display area.

## <4> Profile tool

Contains buttons to draw various profile lines, such as a straight line and circles.

## <5> Line roughness measurement settings

Selects line roughness measurement type from Roughness, Primary, and Waviness.

📖 Changing the Measurement Type (Page 10-8)

📖 Setting a Cutoff Value (Page 10-8)

📖 Setting Filter (Page 10-9)

📖 Line roughness measurement detail settings (Page 10-11)

## <6> Profile display area

Displays the total profile and the profile of roughness/primary/waviness for the profile line (or the selected profile line if there are more than one profile line) on the image.

📖 Profile Display Area (Page 10-5)

## <7> [Cancel] button

By clicking, the [Line roughness] window is closed without applying the setting contents.

## <8> [OK] button

By clicking, the [Line roughness] window is closed, and the measurement result is applied in the grid sheet

## <9> [Print/Save] button

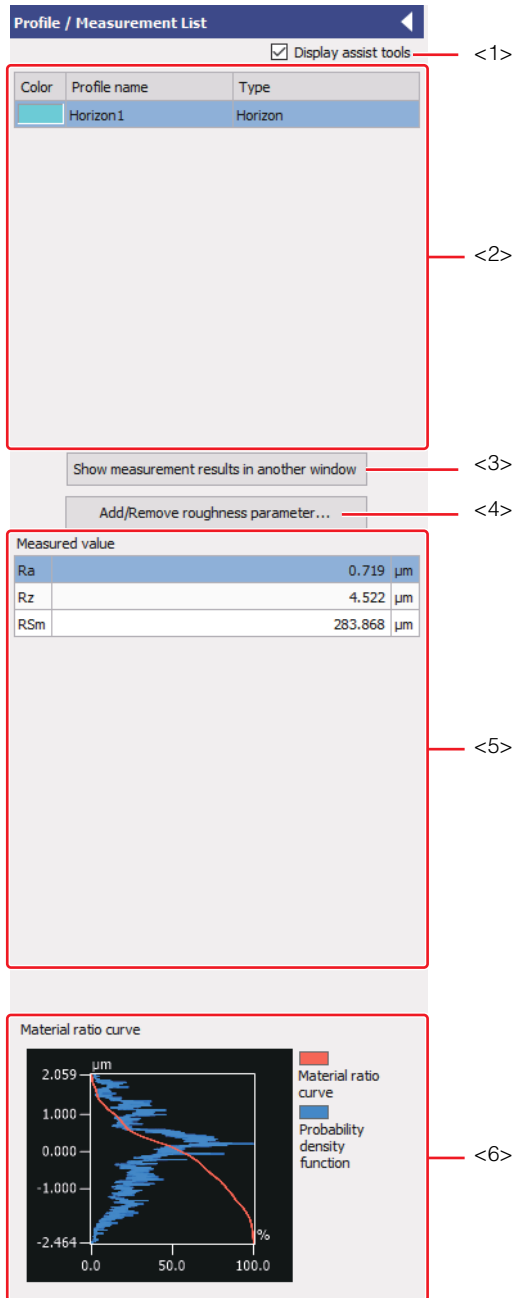
Output the screen display contents in the following formats.

- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

📖 Outputting the Screen Display Contents (Page 6-11)

## Profile/Measurement List

The profile/measurement list displays the list of profiles and elements placed on the image, and the list of measurement results.



### <1> [Display assist tools] checkbox

Selecting this checkbox displays the list of the assist tools in the profile list.

### <2> Profile list

Displays the list of total profile and assist tools.



The element being selected in the image display area is highlighted in this list.

### <3> [Show measurement results in another window] button

Displays the result displayed on the [Measured value] in a different window. The displayed result can be saved as a text file in CSV format.

### <4> [Add/Remove roughness parameter...] button

Sets Show or Hide of the roughness parameter displayed on the measured value.


**Reference** Click the  button to collapse and hide the profile/measurement results list into the left edge of the window. Click the  button to display it again.

## <5> Measured value

Displays the measured values for the following surface texture parameters of the selected profile in the image display area.

Parameter name	Roughness	Primary	Waviness
Maximum profile peak height	Rp	Pp	Wp
Maximum profile valley depth	Rv	Pv	Wv
Maximum height of profile	Rz	Pz	Wz
Mean height of profile elements	Rc	Pc	Wc
Total height of profile	Rt	Pt	Wt
Arithmetical mean height	Ra	Pa	Wa
Root mean square height	Rq	Pq	Wq
Skewness	Rsk	Psk	Wsk
Kurtosis	Rku	Pku	Wku
Mean width of the profile elements	RSm	PSm	WSm
Root mean square gradient	RΔq	PΔq	WΔq
Load length ratio	Rmr (c)	Pmr (c)	Wmr (c)
Cut level difference	Rδc	Pδc	Wδc
Relative load length ratio	Rmr	Pmr	Wmr
Cross point average roughness	RzJIS	—	—
Core height	Rk	Rk	Rk
Load length ratio that separates the profile peak area and core	Mr1	Mr1	Mr1
Load length ratio that separates the profile valley area and core	Mr2	Mr2	Mr2
Reduced peak height	Rpk	Rpk	Rpk
Reduced dale height	Rvk	Rvk	Rvk
Material-filled profile peak area	A1	A1	A1
Lubricant-filled profile valley area	A2	A2	A2
High spot count	HSC	HSC	HSC
Peak count/cm	Pc/cm	Pc/cm	Pc/cm
Peak count	RPc	PPc	WPc
Expansion length	RLo	PLo	WLo
Expansion length ratio	Rlr	Plr	Wlr
Arithmetic mean tilt angle	RΔa	PΔa	WΔa
Arithmetic mean wavelength	Rλa	Pλa	Wλa
Root mean square tilt angle	RΔq	PΔq	WΔq
Root mean square wavelength	Rλq	Pλq	Wλq
Evaluation length	Length of the part between vertical cursors in the X axis direction		
Sampling length	The cutoff value $\lambda_c$ is displayed for the roughness curve; the cutoff value $\lambda_f$ is displayed for the waviness curve; and the evaluation length is displayed for the primary curve. However, the value is equivalent to the evaluation length when the evaluation length is shorter than the cutoff value.		

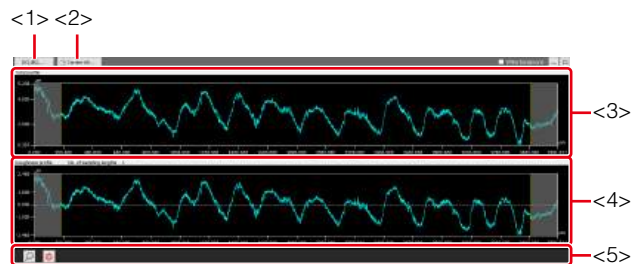
Parameter name	Roughness	Primary	Waviness
Number of sampling length	The calculated number of sampling length is displayed according to the cutoff value $\lambda_c$ for the roughness curve, and according to the cutoff value $\lambda_f$ for the waviness curve. However, the number of evaluation length is 1 when the evaluation length is shorter than the cutoff value.		

For details of each parameter, refer to  Roughness Definitions (Page 10-14).

## <6> Material ratio curve

The material ratio curve (BAC) and the probability density function (ADF) are displayed.

## Profile Display Area



### <1> [DCL/BCL] button

DCL (Dark Cut Level)/BCL (Bright Cut Level) interpolates the height data above the dark cut level (lower threshold) or the bright cut level (upper threshold) with the surrounding data when a portion of the laser intensity of the laser intensity profile graph is judged as abnormal (too low or too high).

### <2> [Correct tilt] button

Performs tilt correction for total profile. A roughness/primary/waviness profile will be created from total profile after the tilt correction.

### <3> Total profile

Displays the roughness/primary/waviness curve obtained using the profile line settings.

### <4> Roughness/primary/waviness profile

For total profile, displays the roughness/primary/waviness curve to which the cutoff value specified in the line roughness measurement settings is applied.

### <5> Profile operation controls

Changes the method to view the roughness/primary/waviness profile and total profile in the direction of the Z axis.

# Line Roughness Measurement

## Displaying the Line Roughness Measurement Window

Display the line roughness measurement window to perform measurement.

### 1 Open the measurement data or analysis result file.

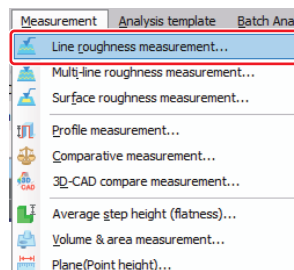
Opening/Closing File (Page 3-2)



Perform the following preprocessing as needed.

- Reference Plane Settings
  - Reference Plane Settings (Page 5-3)
- Leveling
  - Leveling (Page 5-9)
- Surface shape correction
  - Surface Shape Correction (Page 5-11)
- Inverting an Image
  - Inverting an Image (Page 5-16)
- Smoothing
  - Smoothing (Page 5-17)
- Height cut level
  - Height Cut Level (Page 5-19)
- DCL/BCL
  - DCL/BCL (Page 5-22)
- Missing data removal
  - Missing Data Removal (Page 5-25)
- Noise removal
  - Noise Removal (Page 5-26)
- Set invalid area
  - Set invalid area (Page 5-28)
- Screen rotation
  - Screen rotation (Page 5-29)
- Image trimming
  - Image trimming (Page 5-30)
- C-DIC setting
  - C-DIC setting (Page 5-32)
- Auto Position Adjustment
  - Auto Position Alignment (Page 5-34)

### 2 Select [Line roughness measurement] from the [Measurement] menu. Or click the [Line R] button on the toolbar.



The line roughness measurement window appears.

## Setting Profile Line

Set a profile line at the measurement position on the image displayed in the line roughness measurement window. When the profile line is specified on the image, a profile graph and measurement result at the measurement position are displayed.

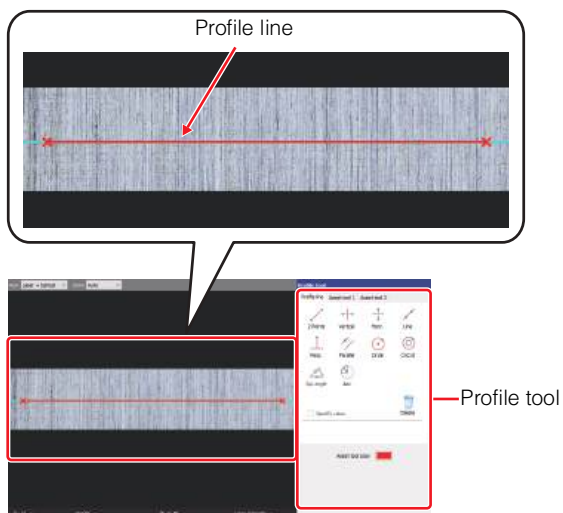
- 1 Select the [Assist tool 1] tab or [Assist tool 2] tab in the profile tool, and click the desired button to place an element on the image as needed.

A profile line consists of elements such as point and line. If you place these elements on the measurement position in advance using the buttons on the [Assist tool 1] tab or [Assist tool 2] tab, you can draw a profile line accurately and efficiently in a way that is similar to actual drawing.

- 📖 What is an Element? (Page A-22)
- 📖 How to use assist tools (Page 6-25)

- 2 Click the desired button on the [Profile line] tab in the profile tool and draw a profile line on the image.

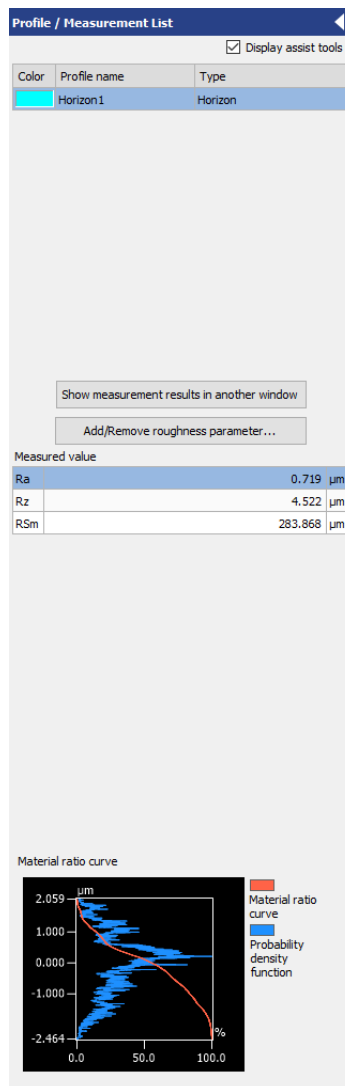
- 📖 How to use profile line tool (Page A-26)



When the profile line is drawn on the image, the total profile and the roughness/primary/waviness profile are displayed in the profile display area.

Because the total profile is updated in real time during the drawing process of the profile line, you can draw the profile line while confirming the waveform.

Additionally, the Profile/Measurement List displays the measurement results.



## Changing the Measurement Type

### 1 Change the measurement type in [Measurement type] of [Line roughness measurement settings].

By default, Roughness is selected.

#### Roughness

Displays a graph of roughness profile (R: Roughness).

#### Primary

Displays a graph of primary profile (P: Primary).

#### Waviness

Displays a graph of waviness profile (W: Waviness).

## Setting a Cutoff Value

The cutoff value is an ISO standard parameter. The wavelength at which the gain of the phase compensation filter equals 50%.

The input fields ( ) for the cutoff values that correspond to the roughness, primary, and waviness are as mentioned below.

	$\lambda_s$	$\lambda_c$	$\lambda_f$
Roughness profile			-
Primary profile		-	-
Waviness profile			

### 1 Select the cutoff value in [Cutoff] of [Line roughness measurement settings].

You can set each parameter by selecting a value from the dropdown list or typing a value directly.

The minimum value for the  $\lambda_s$  is double of the pixel length, and the maximum value is one half of the profile length in the X axis direction.

The minimum value for the  $\lambda_c/\lambda_f$  is the larger value of either 5 times of the pixel length or 0.025 mm, and the maximum value is the minimum option that is longer than the profile length in the X axis direction.

#### ● Number of sampling length

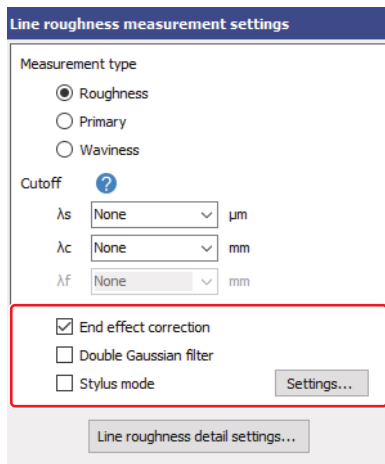
The calculated number of sampling length is displayed according to the cutoff value  $\lambda_c$  for the roughness curve, and according to the cutoff value  $\lambda_f$  for the waviness curve.

However, the number of evaluation length is 1 when the evaluation length is shorter than the cutoff value.

## Setting Filter

Sets the filter to ON/OFF.

- 1 Click the **[Double Gaussian filter]** checkbox to select ON/OFF.



### [End effect correction] checkbox

When Double gaussian filter is selected, selecting [End effect correction] checkbox can correct the circumference of the surface so it is not distorted.

### [Double Gaussian filter] checkbox

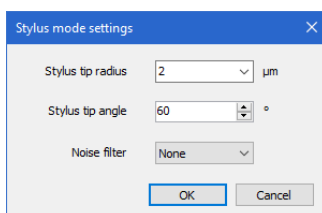
Select this checkbox to enable the filter.

### [Stylus mode] checkbox

Enables the stylus mode.

### [Settings] button

Clicking this button displays the [Stylus mode settings] dialog box.



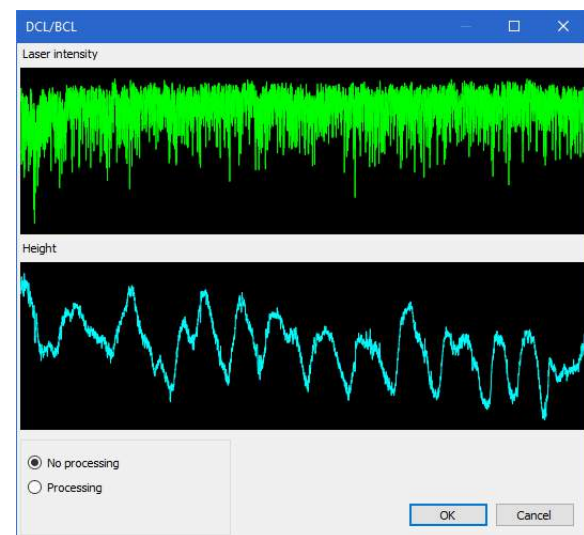
Sets the radius and angle of the stylus tip and the noise filter.

## Correcting the DCL/BCL

DCL (Dark Cut Level)/BCL (Bright Cut Level) cuts the laser intensity level above the dark cut level (lower threshold) or the bright cut level (upper threshold) with the surrounding data when a portion of the laser intensity of the laser intensity profile graph is judged as abnormal (too low or too high).

- 1 Click the **[DCL/BCL]** button in the profile display area.

The [DCL/BCL] window appears.



- 2 Click the **[Processing]** radio button.

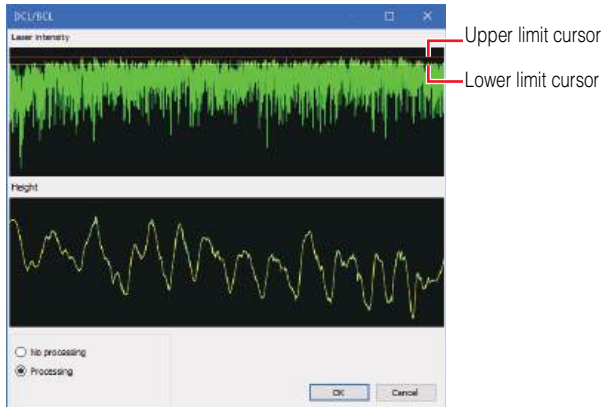
### [No processing] radio button

The changes in DCL/BCL are not reflected in the display.

### [Processing] radio button

Smooths height data (cross section Profile) by smoothing and cutting level processing.

- 3 Drag the upper limit and lower limit cursors to set the threshold.**



The height profile graph after correction is displayed in the [DCL/BCL] window.

#### Upper limit cursor

The laser intensity data higher than the cursor will be cut (bright areas).

#### Lower limit cursor

The laser intensity data lower than the cursor will be cut (dark areas).

- 4 Click the [OK] button in the [DCL/BCL] window.**

This executes the correction.

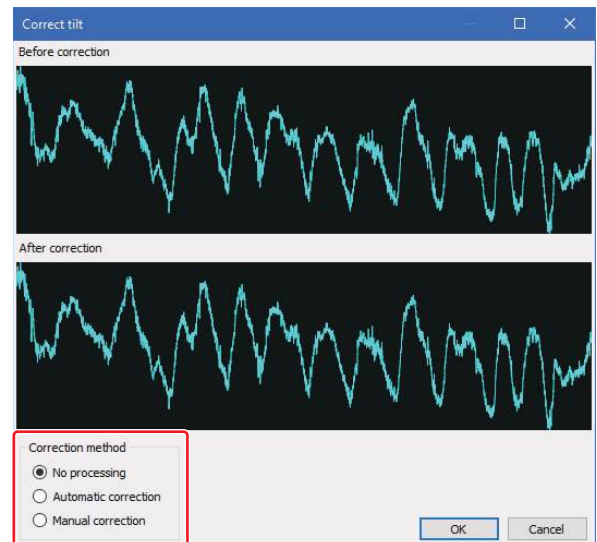
## Correcting the Tilt of Total Profile

Correct the tilt of the profile graph so that the total profile displayed tilted is level.

- Corrections are applied only to the total profile of the measurement data. No changes are made to the image that was measured.
- Correction is set and applied to each line individually.

- 1 Click the [Correct tilt] button in the profile display area.**

The [Correct tilt] window appears.



- 2 Select the correction method.**

#### [No processing] radio button

Cancels the tilt correction.

#### [Automatic correction] radio button

Performs the tilt correction automatically.

#### [Manual correction] radio button

Performs the tilt correction manually.

- 3 Click the [OK] button in the [Correct tilt] window.**

This executes the correction.

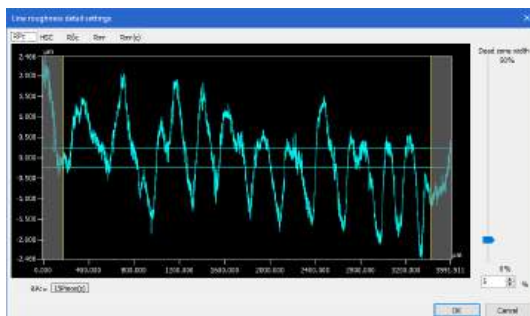
## Line roughness measurement detail settings

When measuring the following parameters, set the threshold values for dead zone width, cut level, etc.

- Peak count
- High spot count
- Cut level difference
- Relative load length ratio
- Load length ratio

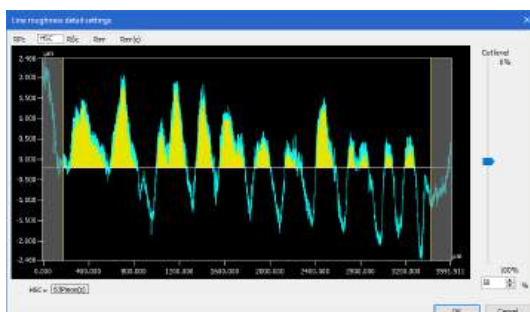
### ● Peak count

Use the slider to move the two reference lines on the graph and set the dead zone widths (RPC/PPC/WPC) of the roughness, primary and waviness profiles to the range between 0 and 50%.



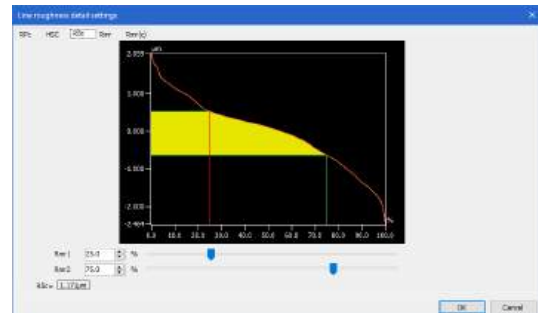
### ● High spot count

Use the slider to move the reference line indicating the cut level and set the cut levels (HSC) of the roughness, primary and waviness profiles to the range between 0 and 100%.



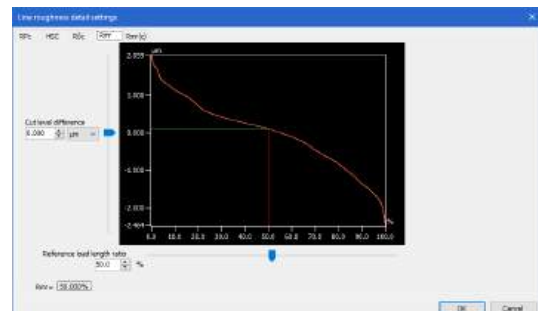
### ● Cut level difference

Use the slider to move the reference lines (Rmr1 and Rmr2) on the graph, and obtain the cut level difference ( $R\delta c/P\delta c/W\delta c$ ) of the roughness, primary and waviness profiles.



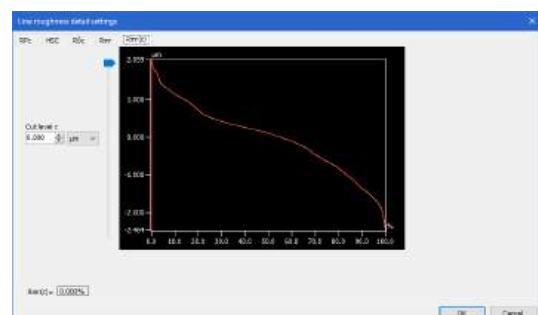
### ● Relative load length ratio

Use the slider to move the cut level difference or reference load length ratio on the graph, and obtain the cut level difference ( $Rmr/Pmr/Wmr$ ) of the roughness, primary and waviness profiles.



### ● Load length ratio

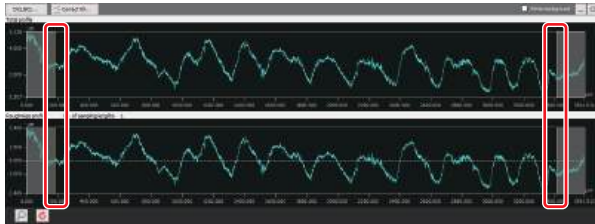
Use the slider to enter the cut level C value or move within the range from 0 to 100%, and obtain the load length ratio ( $Rmr(c)/Pmr(c)/Wmr(c)$ ).



## Setting Evaluation Length

As required, specify an evaluation length on the profile graph. You can set an evaluation length by dragging two yellow vertical cursors that are displayed on the profile graph.

The cursor positions are shared between the roughness/primary/waviness profiles and total profile.



**Reference** The evaluation length is set automatically, based on the cutoff value  $\lambda_c$  when the measurement type is [Roughness] and the cutoff value  $\lambda_f$  when the measurement type is [Waviness].

For the horizontal direction of the roughness/primary/waviness profiles and total profile, always the whole profiles are displayed fitting to the display area. By default (right after the profile is updated), both of the roughness/primary/waviness profiles and total profile are displayed fitting to the display area. You can configure the axis setting for the Z axis (vertical axis display of the profile graph).


**Point** You can specify the range of the Z axis for each of total profile and the roughness/primary/waviness profile individually. However, you cannot operate the X axis.

### 1 Click the (specify value) button in the profile operation controls.

The [Set axis] dialog box appears.

Z Axis	
Total profile	Max: 5.238 μm
	Min: 0.307 μm
Roughness profile	Max: 2.466 μm
	Min: -2.466 μm

### 2 Set the maximum and minimum values on the Z axis of the desired profile graph, and click the [OK] button.

**Reference** To restore the Z axis scaling to the original state, click the  (Reset) button.

## Applying the Measurement Result in the Main Screen




### 1 Click the [OK] button in the [Line roughness] window.

The [Line roughness] window is closed, and the measurement result is applied in the grid sheet.

**Reference** By clicking the [Cancel] button, the [Line roughness] window is closed without applying the setting contents.

## Operating the Grid View Area

Measurement data information and measurement analysis results are displayed on the grid view area. For setting the display contents, see the following.

-  Grid view area (Page 2-8)
-  Inserting items (Page 2-11)
-  Sorting (Page 2-12)

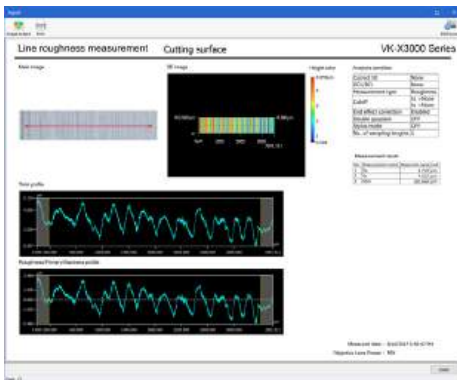
## Exporting Measurement Result

Line roughness measurement results can be output to a report or an Excel file.

### ● Report output

Outputs the results in a defined format in another window.


Refer to  Report (Page 3-9).



### ● Exporting to Excel file

Outputs the image data and text to Excel in grid display layout.


Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to  Exporting as Excel File (Page 3-15).

### ● Save CSV

Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

Refer to  Exporting measurement result (Page 3-13).

# Roughness Definitions

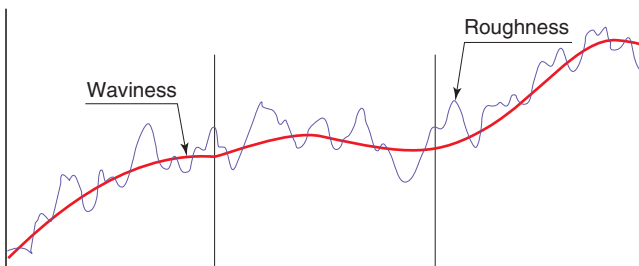
## Surface Roughness Profile

### ■ Roughness (surface roughness)

Roughness (surface roughness) has a complicated shape in which there are continuous peaks and valleys whose height, depth and intervals differ. The surface condition wherein uneven surfaces appear in a continuing sequence in relatively short cycles and at relatively shorter intervals than the depth is called the roughness (surface roughness).

### ■ Waviness

Waviness refers to uneven surfaces that appear periodically at longer intervals than the roughness, which can be defined as deviation from an ideal surface that appears repeatedly at relatively longer intervals than the depth.



### ■ Traced profile

Traced profile refers to the surface profile of the sample which is calculated from the result measured using the VK-X3000 Series.

### ■ Total profile

Total profile means a curve which is sampled (digitalized) at regular intervals as a coordinate (a continuously changing graph) of which measured curve consists of vertical and horizontal axes.

In the surface roughness measurement where surface irregularity is measured by tracing the stylus, up and down changes in the continuously moving stylus need to be sampled and digitalized at regular intervals. The VK-X3000 Series is designed to perform the sampling previously at regular intervals when it measures the surface. A profile graph is equivalent to the total profile.

### ■ Profile

Profile refers to a generic name of curves, such as total profile, primary profile, roughness profile and waviness profile.

### ■ Primary profile

Primary profile means a curve in which a low-pass filter of phase compensation type of the cutoff value  $\lambda_s$  is applied to the total profile.

### ■ Roughness profile

Roughness profile means a curve in which only high frequency component of the primary profile is recorded through a high-pass filter of phase compensation type (cutoff value  $\lambda_c$ ).

### ■ Waviness profile

Primary profile means a curve in which a low-pass filter of phase compensation type of the cutoff value  $\lambda_f$  and  $\lambda_c$  is applied to the total profile.

### ■ Average line

As the average line, there are 3 types of average lines, such as average line for roughness profile, average line for waviness profile and average line for primary profile, all of which are curves.

### ■ Average line for roughness profile

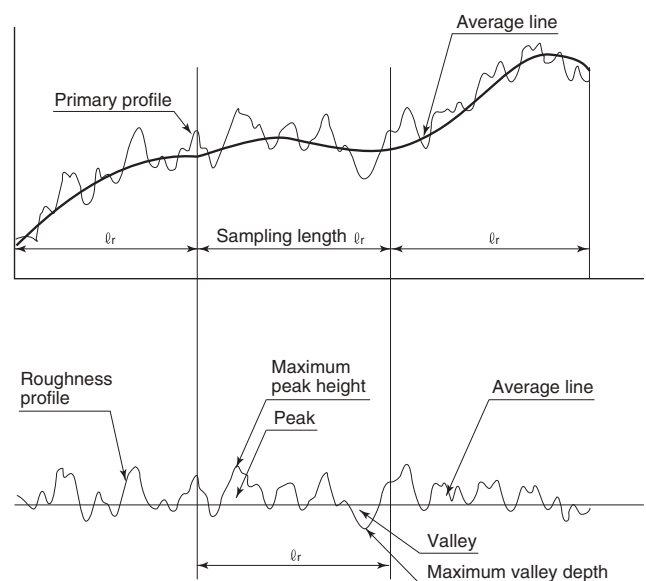
Average line for roughness profile means a curve in which low frequency component cut by a low-pass filter of phase compensation type  $\lambda_c$  (low-pass filter) is recorded.

### ■ Average line for waviness profile

Average line for waviness profile means a curve in which low frequency component cut by a low-pass filter of phase compensation type  $\lambda_f$  (low-pass filter) is recorded.

### ■ Average line for primary profile

Average line for primary profile means a curve which indicates a nominal shape applied to the primary profile by means of the least squares method.



### ■ Sampling length

Arithmetic mean deviation and other roughness parameters are determined based on the extracted part of a given length from the profile.

This extracted length is called the "sampling length." The sampling lengths of the roughness profile and waviness profile are equivalent to their respective cutoff values ( $\lambda_c$  for the roughness profile and  $\lambda_f$  for the waviness profile).

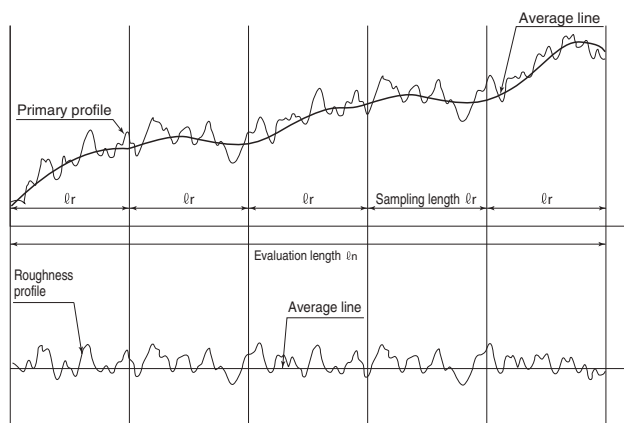
The sampling length of the primary profile is equivalent to the profile's evaluation length.

### ■ Evaluation length

Evaluation length refers to the part of a given length extracted from the profile in order to determine arithmetic mean deviation and other roughness parameters.

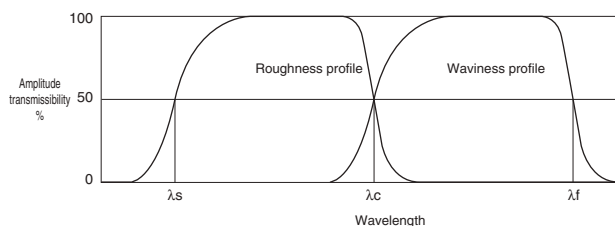
An evaluation length must contain at least one sampling length. Generally, an evaluation length is five times the corresponding sampling length.

However, there are no specific rules on evaluation lengths used for waviness parameters.



### ■ Cutoff (cutoff value)

The cutoff refers to the predetermined wavelength to be removed from a primary profile. A roughness profile is created by removing the long-wavelength component from the primary profile, and a waviness profile is created by removing the short-wavelength component from the primary profile. When the contact-type surface roughness measuring equipment was the analog equipment that performs the measurement using its electric circuit consisting of capacitors and resistors, 2 CR filter was normally used. With digitalization becoming more popular however, the phase compensation digital filter (Gaussian filter) has been widely used in recent years. The cutoff used for Multifile Analyzer Software is Gaussian filter as well.



### ISO4287:1997

Multifile Analyzer Software uses equations that comply with "ISO 4287: 1997 Surface roughness-Definitions" and "ISO 13565: 1996". For more information, refer to the "ISO 4287: 1997 " and "ISO 13565: 1996" standards issued by standardization organizations (BSI, DIN, JSA, etc.).

#### Reference

When discussing parameters, Pp is Highest primary profile peak, Rp is Highest roughness profile peak, and Wp is Highest waviness profile peak. Each refers to the corresponding curve to profile curve. However, some of the parameters for roughness and waviness profiles are referred to as different language for reasons of history or convenience.

### ■ Maximum profile peak height

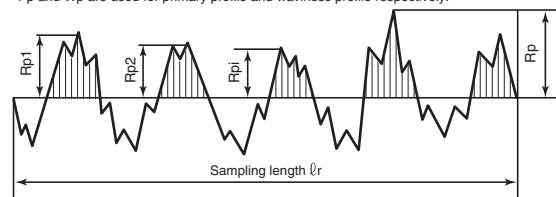
Maximum profile peak height indicates the point along the sampling length at which the curve is highest.

#### Reference

- Peaks are determined for each region that exceed the average line.
- Rpi for each curve takes the average height of the roughness profile (when P, it is a primary profile, and when W, it is a waviness profile) to be 0 and determines the height of position x along the curve.

$$R_p = \max (R_{pi})$$

\* Pp and Wp are used for primary profile and waviness profile respectively.



Maximum profile peak height (for a roughness profile)

### Maximum profile valley depth

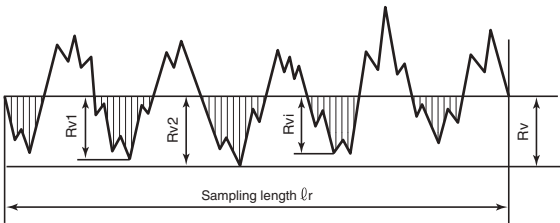
Maximum profile valley depth indicates the point along the sampling length at which the valley is deepest.

Reference

- Valleys are areas that are lower than the average line.
- $R_{vi}$  for each curve takes the average height of the roughness profile (when P, it is a primary profile, and when W, it is a waviness profile) to be 0 and determines the depth of the measurement line at position  $x$  along the curve.

$$R_v = |\min(R_{vi})|$$

\*  $P_v$  and  $W_v$  are used for primary profile and waviness profile respectively.

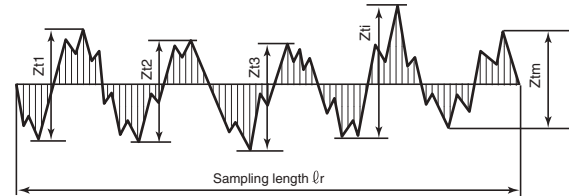


Maximum profile valley depth (for a roughness profile)

### Mean height of profile elements

Mean height of profile elements indicates the average value of the height of the curve element along the sampling length.

$$R_c, P_c, W_c = \frac{1}{m} \sum_{i=1}^m Z_{ti}$$



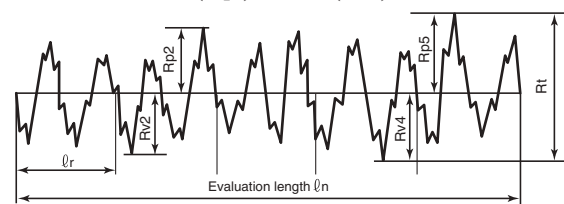
Mean height of profile elements (for a roughness profile)

Profile elements consist of a peak and a neighboring valley. The peaks (or valley) that constitutes element have minimum height and length standards such that they will be treated as noise and considered a part of the preceding valley (or peak) if the height (depth) is less than 10% of the maximum height or the length is less than 1% of the segment length.

### Total height of profile

Total height of profile is the vertical distance between the Maximum profile peak height and the Maximum profile valley depth along the evaluation length.

$$R_t, P_t, W_t = \max(R_{pi}) + \max(R_{vi})$$

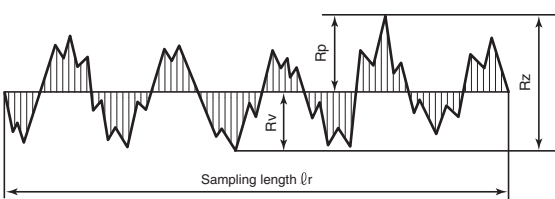


### Maximum height of profile

Maximum height of the profile indicates the absolute vertical distance between the Maximum profile peak height and the Maximum profile valley depth along the sampling length.

$$R_z = R_p + R_v$$

\*  $P_z$  and  $W_z$  are used for primary profile and waviness profile respectively.



Maximum height of profile curve (for a roughness profile)

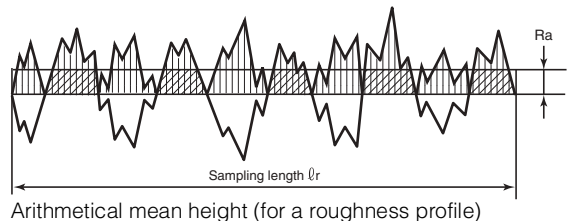
Reference

When dealing with roughness profile,  $R_z$  is referred to as Maximum roughness while  $W_z$  is referred to as Maximum waviness when dealing with waviness profile.

### ■ Arithmetical mean height

Arithmetical mean height indicates the average of the absolute value along the sampling length.

$$Ra, Pa, Wa = \frac{1}{\ell_r} \int_0^{\ell_r} |Z(x)| dx$$



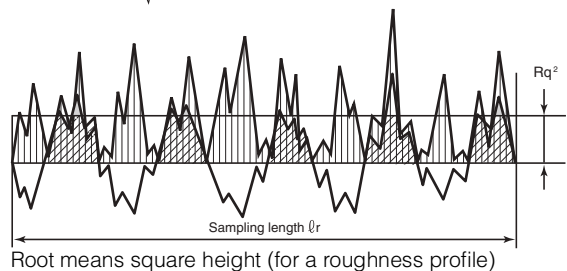
**Reference** When dealing with the roughness profile, Ra is referred to as Arithmetic mean roughness while Wa is referred to as Arithmetic mean waviness for the waviness profile.

### ■ Root mean square height

Root mean square deviation indicates the root mean square along the sampling length.

**Reference** For the roughness profile, Rq is referred to as Root-mean-square roughness while Wq is referred to as Root-mean-square waviness for the waviness profile.

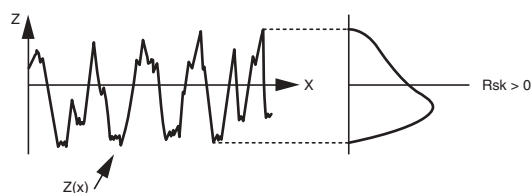
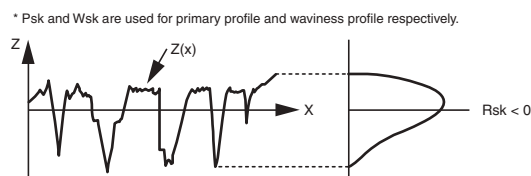
$$Rq, Pq, Wq = \sqrt{\frac{1}{\ell_r} \int_0^{\ell_r} Z^2(x) dx}$$



### ■ Skewness

Skewness uses the cube of the root mean square deviation to display the dimensionless cube of the sampling length Z(x).

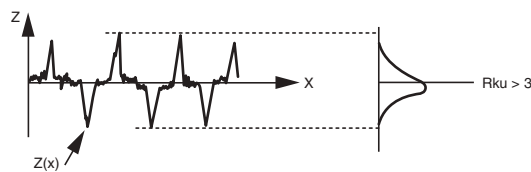
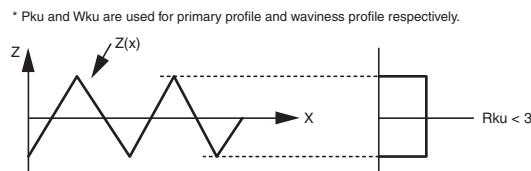
$$Rsk = \frac{1}{Rq^3} \left[ \frac{1}{\ell_r} \int_0^{\ell_r} Z^3(x) dx \right]$$



### ■ Kurtosis

Kurtosis uses the fourth power of the root mean square deviation to display the dimensionless fourth power of the sampling length Z(x).

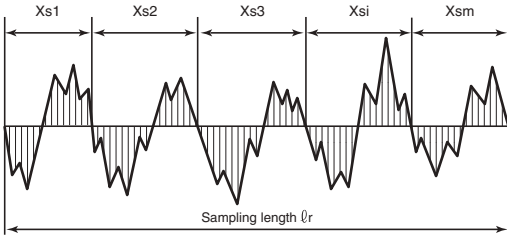
$$Rku = \frac{1}{Rq^4} \left[ \frac{1}{\ell_r} \int_0^{\ell_r} Z^4(x) dx \right]$$



**■ Mean width of the profile elements**

Mean width of the profile elements indicates the average value of the length of the profile element along the sampling length.

$$RSm, PSm, WSm = \frac{1}{m} \sum_{i=1}^m X_{si}$$



Mean width of the profile elements (for a roughness profile)

X<sub>si</sub> is the length of a single profile element. The peaks (valley) that constitute elements have minimum height and length standards such that they will be treated as noise and considered a part of the preceding valley(peak) if the height (depth) is less than 10% of the maximum height or the length is less than 1% of the segment length.

**■ Root mean square slope**

Root mean square slope indicates the root mean square of the local tilt dZ/dX along the sampling length.

$$R\Delta q, P\Delta q, W\Delta q = \sqrt{\frac{1}{l_r} \int_0^{l_r} \left[ \frac{dZ(x)}{dx} \right]^2 dx}$$

The local tilt refers to the derivative of Z (x). Derivatives generally use the seven-point formula shown below. (Because the first three points on either end lack sufficient data, three or five point formulae are used.)

$$\frac{dZ_i}{dx_i} = \frac{(Z_{i+3} - 9Z_{i+2} + 45Z_{i+1} - 45Z_{i-1} + 9Z_{i-2} - Z_{i-3})}{60x}$$

**■ Cross point average roughness (Rz JIS)**

Cross point average roughness is the value expressed in microns (μm) that is obtained by extracting only the sampling length (l<sub>r</sub>) from the roughness profile in the direction of its average line and finding the sum of the averages of the absolute values of the height (Y<sub>p</sub>) from the highest peak to the 5th peak and those of the height (Y<sub>v</sub>) from the lowest bottom to the 5th bottom.

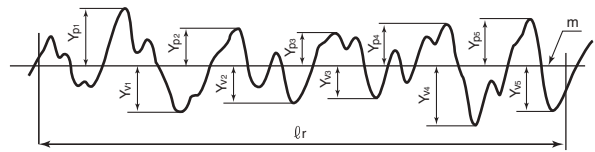
$$Rz = \frac{|Y_{p1} + Y_{p2} + Y_{p3} + Y_{p4} + Y_{p5}| + |Y_{v1} + Y_{v2} + Y_{v3} + Y_{v4} + Y_{v5}|}{5}$$

Y<sub>p1</sub> + Y<sub>p2</sub> + Y<sub>p3</sub> + Y<sub>p4</sub> + Y<sub>p5</sub>

: The Height from the highest peak to the 5th peak of the extracted part for the sampling length (l<sub>r</sub>)

Y<sub>v1</sub> + Y<sub>v2</sub> + Y<sub>v3</sub> + Y<sub>v4</sub> + Y<sub>v5</sub>

: The height from the lowest bottom to the 5th bottom of the extracted part for the sampling length (l<sub>r</sub>)



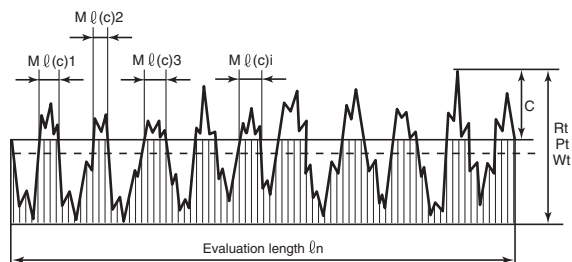
**■ Load length ratio**

**(Rmr (c), Pmr (c), Wmr (c))**

Load length ratio (Z<sub>mr</sub> (c)) is the ratio of the load length M<sub>r</sub> (c) of profile curve elements to the evaluation length at cut level c (height in % or μm).

$$Z_{mr} (c) = \frac{100}{l_n} \sum_{i=1}^m M \ell (c)_i (\%)$$

\* Z<sub>mr</sub> (c) means R<sub>mr</sub> (c), P<sub>mr</sub> (c) and W<sub>mr</sub> (c).



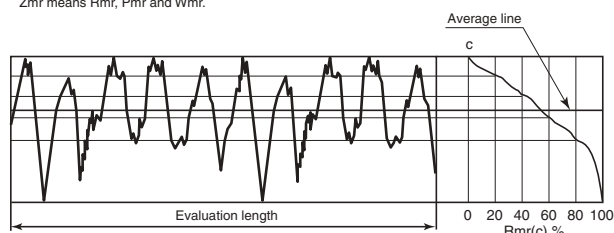
Cut level c (height in % or μm) must be specified.

### ■ Cut level difference (Rδc, Pδc, Wδc)

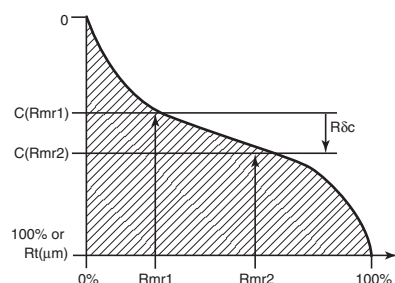
Profile cut level difference (Zδc) shows the cut level c difference of the height trends that agree with the two given load length ratios.

$$Z\delta c = c(Zmr1) - c(Zmr2) : Zmr1 < Zmr2$$

\* Zδc means Rδc, Pδc and Wδc.  
Zmr means Rmr, Pmr and Wmr.



Material ratio curve of profile (for a roughness profile)



Material ratio curve of profile (for a roughness profile)

2 load length ratios, Zmr1 and Zmr2 (load %) must be specified.

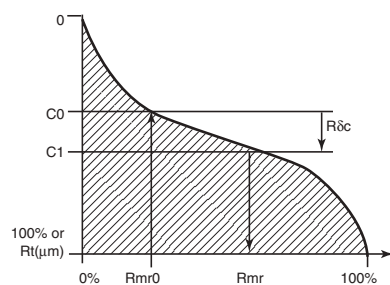
### ■ Relative load length ratio (Rmr, Pmr, Wmr)

Relative load length ratio (Zmr) shows the load length ratio determined by a reference load length ratio (Zmr0) and the cut level difference (Zδc) from the cut level corresponding to the reference load length ratio.

$$Zmr = Zmr(c_1)$$

$$c_1 = c_0 - Z\delta c, c_0 = c(Zmr0)$$

\* Zδc means Rδc, Pδc and Wδc.  
Zmr0 means Rmr0, Pmr0 and Wmr0.



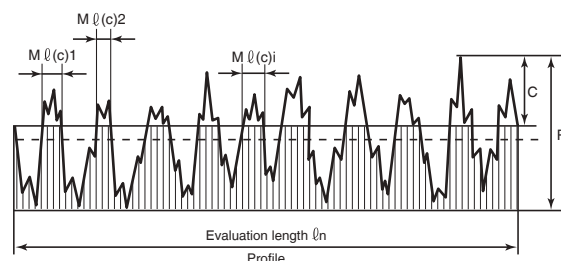
Differing cut levels for profile (for a roughness profile)

Reference load length ratio Zmr0 (% load) and cut level difference ZΔc (height in % or μm) must be specified.

### ■ Material ratio curve (BAC)

Material ratio curve shows the curve of load length ratio determined as the cut level c function.

Load length ratio is the ratio (%) obtained by dividing the total lengths of the length of curve data exceeding the cut level by the entire length (rn).



The number of data points N is the smaller of 4096 and (maximum height / Z calibration).

Maximum height is divided by (N-1) to get the pitch, which is then used for the cut level. Each height is assigned BAC (n) as its load length ratio. n = N is the minimum height. n = 0 is the maximum height. BAC (N) = 100.0, however BAC (0) does not necessarily equal 0.0.

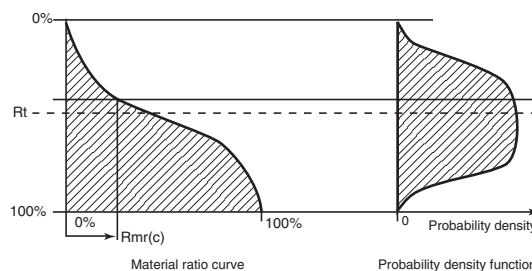
Load length ratio is displayed as a % on the horizontal axis while cut level is displayed on the vertical axis in μm. (Cut height is in the same range as the profile curve graph.)

### ■ Probability density function (ADF)

ADF displays the probability of height Z(x) obtained across the evaluation length. The derivative of the BAC data is also determined. These derivatives use the three-point formula shown below.

$$ADF(n) = \frac{BAC(n+1) - BAC(n-1)}{2}$$

When n=0 or N, calculations are carried out with BAC (-1) = 0.0 and BAC (N+1) = 100.0. Because the vertical range is the same as BAC, this is shown on the same graph. However, the graph is automatically adjusted so that the maximum value on the horizontal is 80%.

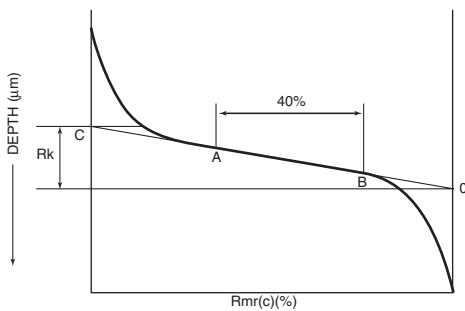


ISO13565:1996

■ Core height (Rk)

Obtain the straight line with the smallest tilt among straight lines that pass 2 points (A and B) whose difference for Zmr (c) value is 40% on BAC. Respective intersections of this line with 0% Zmr (c) and 100% Zmr (c) are point C and point D. The core height is the difference of cut levels that pass point C and point D.

\* Zmr (c) means Rmr (c), Pmr (c) and Wmr (c).



■ Load length ratio that separates the profile peak area and core (Mr1)

■ Load length ratio that separates the profile valley area and core (Mr2)

■ Reduced peak height (Rpk)

■ Reduced dale height (Rvk)

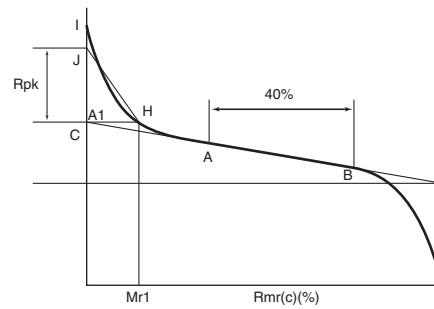
■ Material-filled profile peak area (A1)

Obtain the straight line with the smallest tilt among straight lines that pass 2 points (A and B) whose difference for Zmr (c) value is 40% on BAC. Respective intersections of this line with 0% Zmr (c) and 100% Zmr (c) are point C and point D. The intersection of BAC with the cut level that passes point C and point D is point H. The intersection of BAC with 0%Zmr (c) is I. Then, obtain J on 0%Zmr (c) that creates a triangle CHJ whose area is the same as the area surrounded with the line segments CH and CI, and curve HI.

The distance between point C and point J is the reduced peak height. The Zmr (c) value for H is the load length ratio that separates the profile peak area and core.

The area of the triangle CHJ is the material-filled profile peak area.

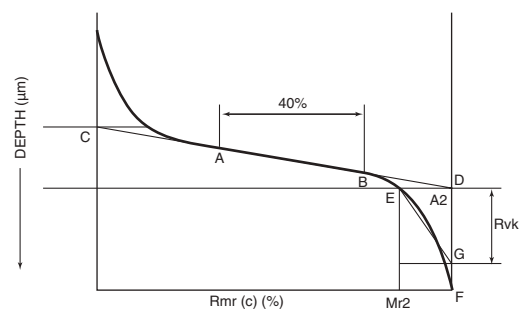
\* Zmr (c) means Rmr (c), Pmr (c) and Wmr (c).



■ Lubricant-filled profile valley area (A2)

Obtain the straight line with the smallest tilt among straight lines that pass 2 points (A and B) whose difference for Zmr (c) value is 40% on BAC. Respective intersections of this line with 0% Zmr (c) and 100% Zmr (c) are point C and point D. The intersection of BAC and the cut level that passes point D is point E, the intersection of BAC and 100% Zmr (c) is F. Then, obtain point G on 100% Zmr (c) that creates a triangle DEG whose area is the same as the area surrounded with the line segments DE and DF, and curve EF.

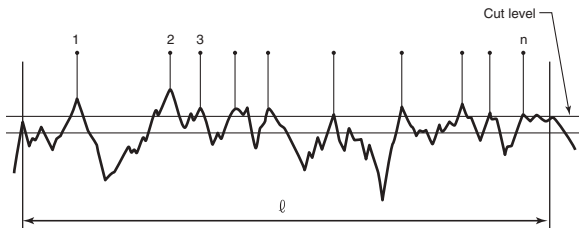
The distance between point D and point G is the reduced dale height. The Zmr (c) value for E is the load length ratio that separates the profile valley area and core. The area of the triangle DEG is the lubricant-filled profile valley area.



## Parameters other than ISO standards

### High spot count (HSC)

High spot count is the number of segments with a height that exceeds a specified cut level at which the profile is cut.



### Peak count/cm (Pc/cm)

Peak count/cm displays the number of elements per centimeter as determined by the inverse of ZSm.

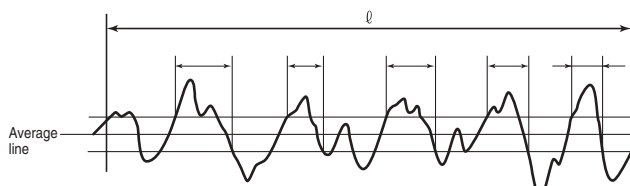
$$Pc/cm = \frac{10000}{ZSm}$$

\* ZPc/cm means RPc/cm, PPc/cm and WPc/cm.

### Peak count (RPC, PPC, WPC)

Peak count creates dead zones at both ends of the average line and counts peaks that start below the dead zone, rise above it and then fall below it.

Dead zone width w (height in %) must be specified.



### Expansion length (RLo, PLo, WLo)

Expansion length displays the length of the profile curve with all of the irregularities stretched out to be flat.

$$ZLo = \sum_{n=1}^{N-1} \sqrt{Y_n^2 + X^2}$$

$$(Y_n = Z_{n+1} - Z_n)$$

\* ZLo means RLo, PLo and WLo.

### Expansion length ratio (Rlr, Plr, Wlr)

Expansion length ratio displays the ratio between the expansion length and the measurement length.

$$Zlr = \frac{ZLo}{(N-1) X}$$

\* Zlr means Rlr, Plr and Wlr.

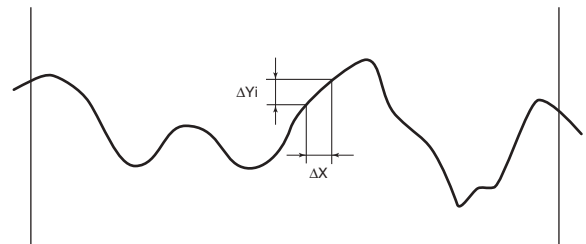
### Arithmetic mean tilt angle (RΔa, PΔa, WΔa)

Arithmetic mean tilt divides the curve into intervals of ΔX in the horizontal direction and displays the average of the absolute value of the tilt (in degrees) of the line that connects the start and end points of each segment.

Multifile Analyzer Software determines the average angle (deg) formed by the line connecting two neighboring points and parallel lines across all segments.

$$ZΔa = \frac{1}{N-1} \sum_{i=1}^{N-1} \left\{ \tan^{-1} \left| \left[ \frac{\Delta Y_n}{\Delta X} \right] \right| \right\}$$

\* ZΔa means RΔa, PΔa and WΔa.



Determining the tilt angle

The tilt angle is determined with  $\tan^{-1} \frac{\Delta Y_n}{\Delta X}$ .

### Arithmetic mean wavelength (Rλa, Pλa, Wλa)

The arithmetic mean wavelength displays the average wavelength estimated from the arithmetic mean tilt angle.

$$Zλa = 360 \times \frac{Za}{ZΔa}$$

\* Zλa means Rλa, Pλa and Wλa.

### Root mean square tilt angle (RΔq, PΔq, WΔq)

Root mean square tilt angle divides the curve into intervals of ΔX in the horizontal direction and displays the square root of the average of the square of the tilt (in degrees) of the line that connects the start and end points of each segment. Multifile Analyzer Software determines the square mean angle (deg) formed by the line connecting two neighboring points and average lines across all segments.

$$ZΔq = \sqrt{\frac{1}{N-1} \sum_{n=0}^{N-1} \left\{ \tan^{-1} \left( \frac{\Delta Y_n}{\Delta X} \right) \right\}^2}$$

\* ZΔq means RΔq, PΔq and WΔq.

**■ Root mean square wavelength****(Rλ<sub>q</sub>, Pλ<sub>q</sub>, Wλ<sub>q</sub>)**

Root mean square wavelength displays the average wavelength estimated from the root mean square tilt angle.

$$Z\lambda_q = 360 \times \frac{Zq}{Z\Delta q}$$

\* Zλ<sub>q</sub> means Rλ<sub>q</sub>, Pλ<sub>q</sub> and Wλ<sub>q</sub>.

# Chapter 11

## Multi-line Roughness Measurement

This chapter describes the multi-line roughness measurement function found on the [Measurement] menu.

When a measurement line is set, this function sets multiple measurement lines parallel to the line, and measures the line roughness. Multiple measurement results can be obtained at a time under the same measurement condition.

Flow of Multi-line Roughness Measurements ....Page 11-2

Screen Used for Multi-line Roughness Measurements ...Page 11-3

Multi-line Roughness Measurement .....Page 11-6

# Flow of Multi-line Roughness Measurements

The flow of multi-line roughness measurements is as follows:

## Setup

### Selecting measurement data

On the grid sheet, select the measurement data on which you want to perform multi-line roughness measurement.

☞ Opening/Closing File (Page 3-2)

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Leveling
- Surface shape correction
- Inverting an image
- Smoothing
- Height cut level
- DCL/BCL
- Missing data removal
- Noise removal
- Set invalid area
- Screen rotation
- Image trimming
- C-DIC setting
- Auto Position Adjustment

☞ Chapter 5, Measurement Preprocessing (Page 5-1)

## Measurement

### Displaying the multi-line roughness measurement window

Display the multi-line roughness measurement window to perform measurement.

☞ Displaying the Multi-line Roughness Measurement Window (Page 11-6)

### Setting profile line

Draw a profile line at the measurement position on the image displayed in the multi-line roughness measurement window. When the profile line is drawn on the image, the total profile at the measurement position and measurement result are displayed. In addition, set the number of lines to be measured in order to eliminate variations depending on the measurement locations.

☞ Setting Profile Line (Page 11-7)

☞ Setting Multiple Measurement Lines (Page 11-7)

### Setting measurement type

Specify the measurement type (Roughness, Primary, Waviness).

☞ Changing the Measurement Type (Page 11-9)

### Setting cutoff value

Set a cutoff value.

☞ Setting a Cutoff Value (Page 11-10)

### Setting Filter

Set the filter to ON/OFF as needed.

☞ Setting Filter (Page 11-10)

### Correcting total profile

As needed, perform a correction to correct the laser intensity level cut and the tilt of the total profile.

☞ Correcting the DCL/BCL (Page 11-11)

☞ Correcting the Tilt of Total Profile (Page 11-12)

### Line roughness measurement detail settings

When measuring the following parameters, set the threshold values for dead zone width, cut level, etc.

- Peak count
- High spot count
- Cut level difference
- Relative load length ratio
- Load length ratio
- ☞ Line roughness measurement detail settings (Page 11-12)

### Setting Evaluation Length

As needed, set segments on the total profile graph, and obtain values for each segment.

☞ Setting Evaluation Length (Page 11-13)

## Post-processing

### Exporting measurement result

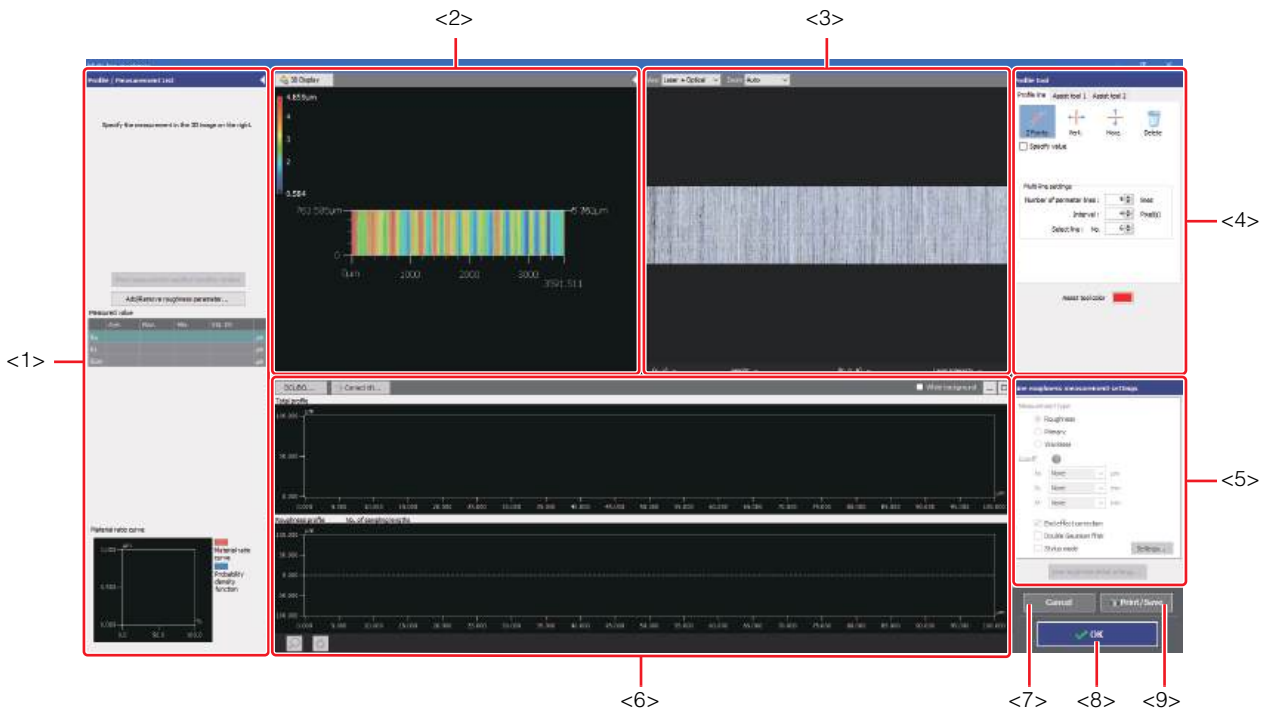
Output the measurement result to Excel file or create a report.

☞ Exporting Measurement Result (Page 11-14)

# Screen Used for Multi-line Roughness Measurements

Select [Multi-line roughness] from the [Measurement] menu, or click the [Multi-line R] button on the toolbar to display the multi-line roughness measurement window.

The following describes the name and functions of each part of the multi-line roughness measurement window.



## <1> Profile/Measurement list

Lists profiles and elements placed on the image, and measurement results.

📖 Profile/Measurement List (Page 11-4)

## <2> 3D display area

Displays a stereoscopic shape of the sample and the cross section of the selected profile.

📖 Configuring Image Display (Page 4-4)

## <3> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. You can set a profile line on this image. You can also change the display type and magnification of the image.

**Reference** Changing the display type and the magnification of the image can be done using the [View] box and the [Zoom] box respectively displayed on the upper part of image display area.

## <4> Profile tool

Contains buttons to draw various profile lines.

## <5> Line roughness measurement settings

Selects line roughness measurement type from Roughness, Primary, and Waviness.

📖 Changing the Measurement Type (Page 11-9)

📖 Setting a Cutoff Value (Page 11-10)

📖 Setting Filter (Page 11-10)

📖 Line roughness measurement detail settings (Page 11-12)

## <6> Profile display area

Displays the total profile and the profile of roughness/primary/waviness for the profile line (or the selected profile line if there are more than one profile line) on the image.

📖 Profile Display Area (Page 11-5)

## <7> [Cancel] button

By clicking, the [Multi-line roughness] window is closed without applying the setting contents.

## <8> [OK] button

By clicking, the [Multi-line roughness] window is closed, and the measurement result is applied in the grid sheet

## <9> [Print/Save] button

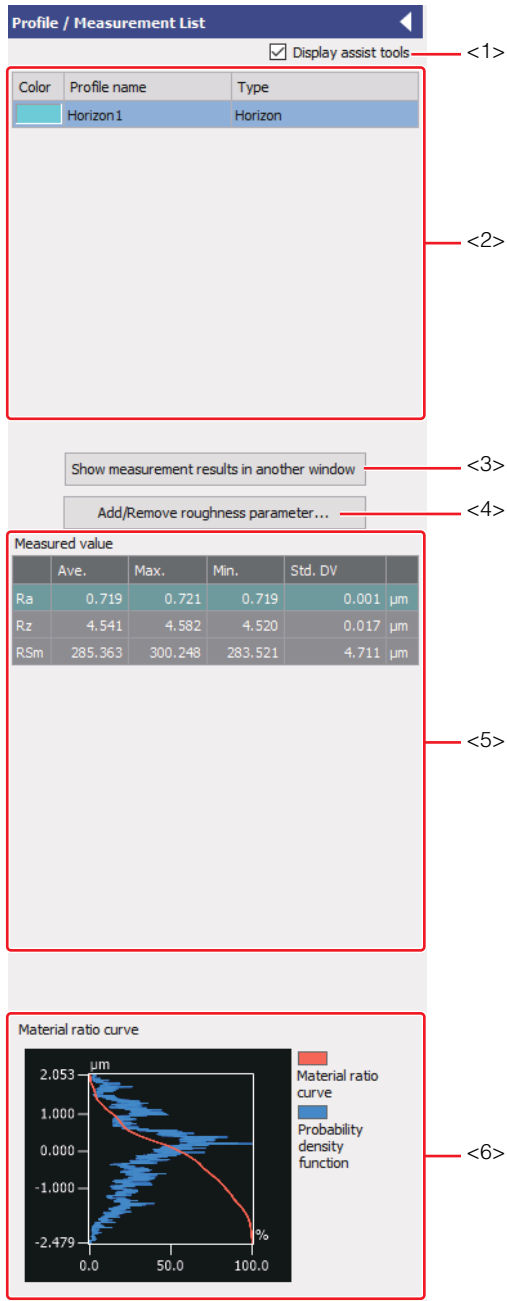
Output the screen display contents in the following formats.

- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

📖 Outputting the Screen Display Contents (Page 6-11)

## Profile/Measurement List

The profile/measurement list displays the list of profiles and elements placed on the image, and the list of measurement results.



### <1> [Display assist tools] checkbox

Selecting this checkbox displays the list of the assist tools in the profile list.

### <2> Profile list

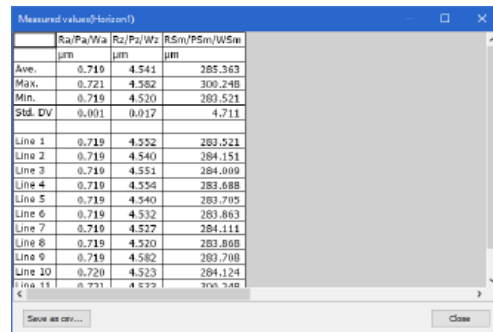
Displays the list of total profile and assist tools.

The element being selected in the image display area is highlighted in this list.

### <3> [Show measurement results in another window] button



Displays each measurement result of multiple total profiles displayed for the profile line setting.

Displays the result displayed on the measured value in a different window. The displayed result can be saved as a text file in CSV format.



### <4> [Add/Remove roughness parameter...] button

Sets Show or Hide of the roughness parameter displayed on the measured value.

**Reference** Click the  button to collapse and hide the profile/measurement results list into the left edge of the window. Click the  button to display it again.

**<5> Measured value**

Displays the measured values for the following surface texture parameters of the selected profile in the image display area.

Parameter name	Roughness	Primary	Waviness
Maximum profile peak height	Rp	Pp	Wp
Maximum profile valley depth	Rv	Pv	Wv
Maximum height of profile	Rz	Pz	Wz
Mean height of profile elements	Rc	Pc	Wc
Total height of profile	Rt	Pt	Wt
Arithmetical mean height	Ra	Pa	Wa
Root mean square height	Rq	Pq	Wq
Skewness	Rsk	Psk	Wsk
Kurtosis	Rku	Pku	Wku
Mean width of the profile elements	RSm	PSm	WSm
Root mean square gradient	RΔq	PΔq	WΔq
Load length ratio	Rmr (c)	Pmr (c)	Wmr (c)
Cut level difference	Rδc	Pδc	Wδc
Relative load length ratio	Rmr	Pmr	Wmr
Cross point average roughness	RzJIS	-	-
Core height	Rk	Rk	Rk
Load length ratio that separates the profile peak area and core	Mr1	Mr1	Mr1
Load length ratio that separates the profile valley area and core	Mr2	Mr2	Mr2
Reduced peak height	Rpk	Rpk	Rpk
Reduced dale height	Rvk	Rvk	Rvk
Material-filled profile peak area	A1	A1	A1
Lubricant-filled profile valley area	A2	A2	A2
High spot count	HSC	HSC	HSC
Peak count/cm	Pc/cm	Pc/cm	Pc/cm
Peak count	RPc	PPc	WPc
Expansion length	RLo	PLo	WLo
Expansion length ratio	RΔr	PΔr	WΔr
Arithmetic mean tilt angle	RDa	PDa	WDa
Arithmetic mean wavelength	Rλa	Pλa	Wλa
Root mean square tilt angle	RΔq	PΔq	WΔq
Root mean square wavelength	Rλq	Pλq	Wλq
Evaluation length	Length of the part between vertical cursors in the X axis direction		
Sampling length	The cutoff value λc is displayed for the roughness curve; the cutoff value λf is displayed for the waviness curve; and the evaluation length is displayed for the primary curve. However, the value is equivalent to the evaluation length when the evaluation length is shorter than the cutoff value.		

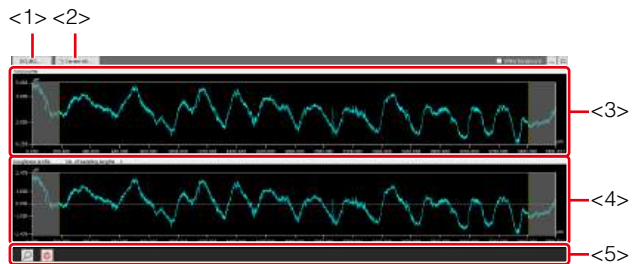
Parameter name	Roughness	Primary	Waviness
Number of sampling length	The calculated number of sampling length is displayed according to the cutoff value λc for the roughness curve, and according to the cutoff value λf for the waviness curve. However, the number of evaluation length is 1 when the evaluation length is shorter than the cutoff value.		

For details of each parameter, refer to Roughness Definitions (Page 10-14).

**<6> Material ratio curve**

The material ratio curve (BAC) and the probability density function (ADF) are displayed.

**Profile Display Area**



**<1> [DCL/BCL] button**

DCL (Dark Cut Level)/BCL (Bright Cut Level) interpolates the height data above the dark cut level (lower threshold) or the bright cut level (upper threshold) with the surrounding data when a portion of the laser intensity of the laser intensity profile graph is judged as abnormal (too low or too high).

**<2>[Correct tilt] button**

Performs tilt correction for total profile. A roughness/primary/waviness profile will be created from total profile after the tilt correction.

**<3> Total profile**

Displays the roughness/primary/waviness curve obtained using the profile line settings.

**<4> Roughness/primary/waviness profile**

For total profile, displays the roughness/primary/waviness curve to which the cutoff value set in the line roughness measurement settings is applied.

**<5> Profile operation controls**

Changes the method to view the roughness/primary/waviness profile and total profile in the direction of the Z axis.

# Multi-line Roughness Measurement

## Displaying the Multi-line Roughness Measurement Window

Display the multi-line roughness measurement window to perform measurement.

### 1 Open the measurement data or analysis result file.

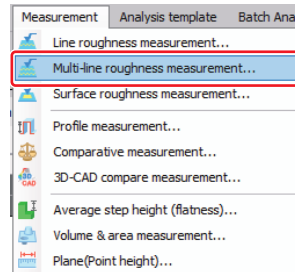
Opening/Closing File (Page 3-2)



Perform the following preprocessing as needed.

- Reference Plane Settings
  - Opening/Reference Plane Settings (Page 5-3)
- Leveling
  - Opening/Leveling (Page 5-9)
- Surface shape correction
  - Opening/Surface Shape Correction (Page 5-11)
- Inverting an Image
  - Opening/Inverting an Image (Page 5-16)
- Smoothing
  - Opening/Smoothing (Page 5-17)
- Height cut level
  - Opening/Height Cut Level (Page 5-19)
- DCL/BCL
  - Opening/DCL/BCL (Page 5-22)
- Missing data removal
  - Opening/Missing Data Removal (Page 5-25)
- Noise removal
  - Opening/Noise Removal (Page 5-26)
- Set invalid area
  - Opening/Set invalid area (Page 5-28)
- Screen rotation
  - Opening/Screen rotation (Page 5-29)
- Image trimming
  - Opening/Image trimming (Page 5-30)
- C-DIC setting
  - Opening/C-DIC setting (Page 5-32)
- Auto Position Adjustment
  - Opening/Auto Position Alignment (Page 5-34)

### 2 Select [Multi-line roughness measurement] from the [Measurement] menu. Or click the [Multi-line R] button on the toolbar.



The multi-line roughness measurement window appears.

## Setting Profile Line

Set a profile line at the measurement position on the image displayed in the multi-line roughness measurement window. When the profile line is specified on the image, a profile graph and measurement result at the measurement position are displayed.

### 1 Select the [Assist tool] tab in the profile tool and click the desired button to place an element on the image as needed.

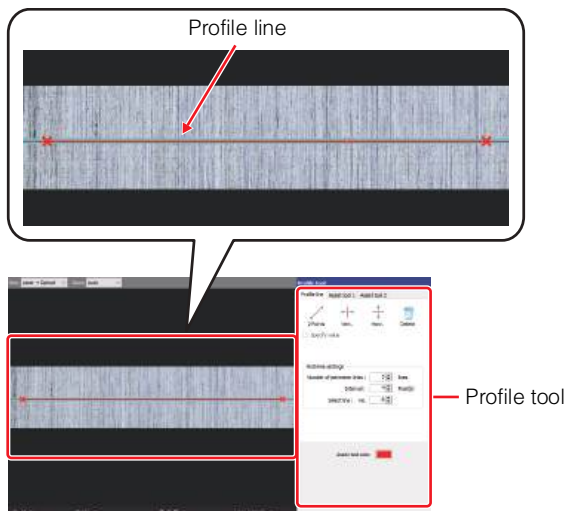
A profile line consists of elements such as point and line. If you place these elements on the measurement position in advance using the buttons on the [Assist tool] tab, you can draw a profile line accurately and efficiently in a way that is similar to actual drawing.

📖 What is an Element? (Page A-22)

📖 How to use assist tools (Page 6-25)

### 2 Click the desired button on the [Profile line] tab in the profile tool and draw a profile line on the image.

📖 How to use profile line tool (Page A-26)

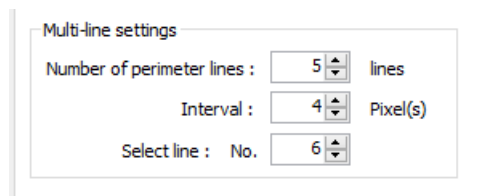


When the profile line is drawn on the image, the total profile and the roughness/primary/waviness profile are displayed in the profile display area.

## Setting Multiple Measurement Lines

### 1 In the [Number of perimeter lines] and [Interval] boxes of the main tools, enter the number of measurement lines and the interval respectively.

Specifying the number of lines to be measured allows variations in measurement areas to be eliminated and statistical results based on multiple pieces of measurement data to be obtained.



#### [Number of perimeter lines] box

In addition to the specified measurement line (reference line), enter the number of lines (n) to be drawn on both sides of the line. When the reference measurement line is drawn, measurement lines of specified number (n) are automatically drawn on both sides of the reference line, and the total number of measurement lines will be  $2n + 1$ .

#### [Interval] box

Enter the interval between measurement lines as the number of lines (m). The greater the value, the larger the interval.

#### [Select line] box

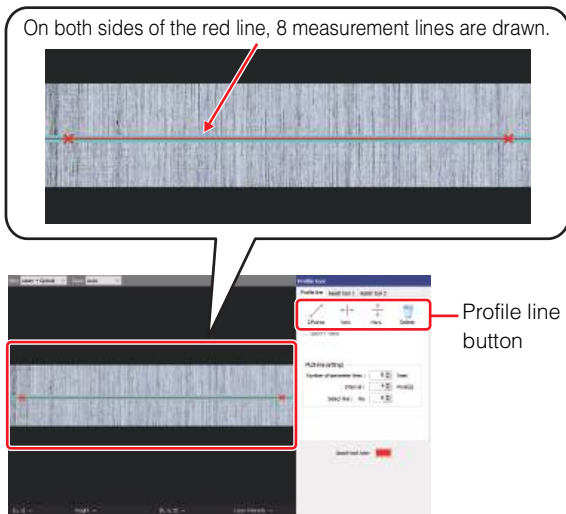
Selects a line number.

The selected measurement line is displayed with the red color, and a profile graph is displayed in the profile graph display area of the multi-line roughness window. The line number 1 is assigned to the lowermost line (or leftmost line).

**2 Click the desired button and draw a profile line on the image.**

Types of Measurement Lines and How to Draw (Page A-22)

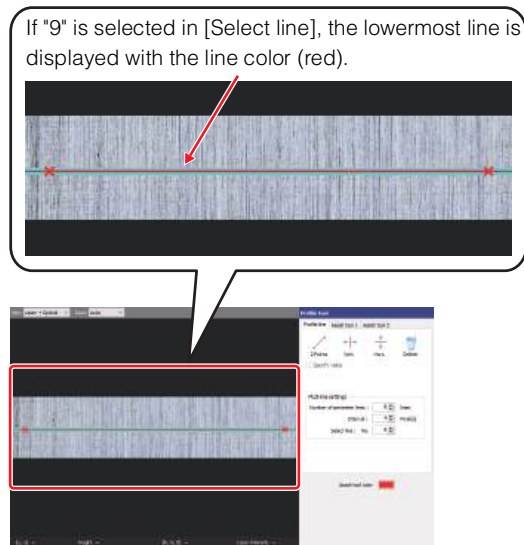
Example: When horizontal lines are drawn with [Number of perimeter lines]: 8 lines and [Interval]: Every 4 lines



When a profile line is drawn on the image, a profile graph is displayed in the profile graph display area. Also, the average of the measurement results for all the measurement lines is displayed in the measurement result display area.

**● Selecting measurement line**

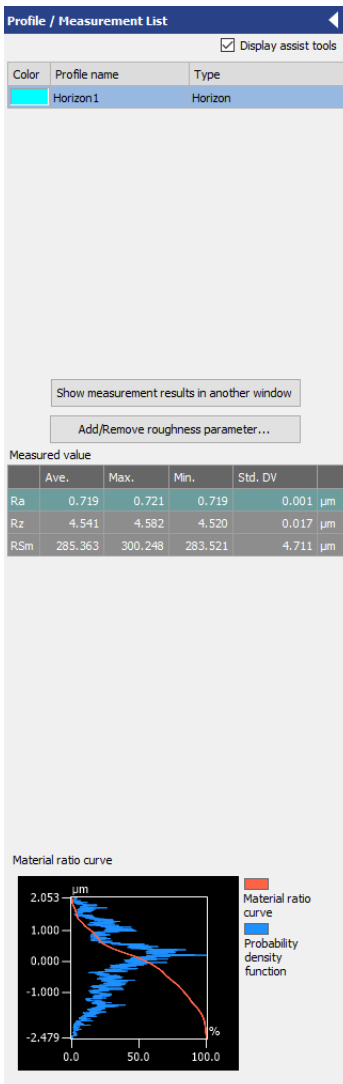
When selecting a line number in the [Select line] box, only the selected measurement line is displayed with the red color, and a profile graph is displayed in the profile graph display area of the multi-line roughness window. (Even if changing the assist tool color to other than red, the selected line is displayed in red) The line number 1 is assigned to the lowermost line (or leftmost line).



Reference

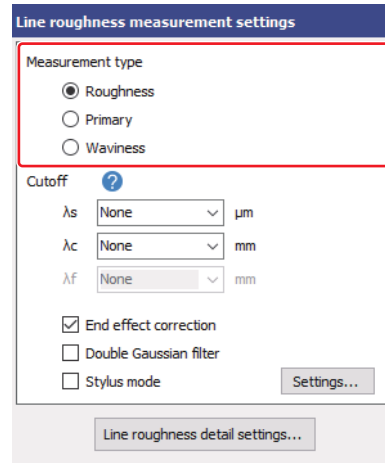
When the [Show measurement results in another window] button is clicked, the measurement results for each total profile are displayed in a list.

The Profile/Measurement List displays the measurement results.



## Changing the Measurement Type

- 1 Change the measurement type in [Measurement type] of [Line roughness measurement settings]. By default, Roughness is selected.



### Roughness

Displays a graph of roughness profile (R: Roughness).

### Primary

Displays a graph of primary profile (P: Primary).

### Waviness

Displays a graph of waviness profile (W: Waviness).

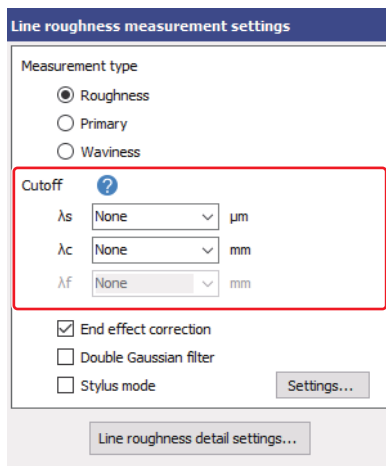
## Setting a Cutoff Value

The cutoff value is an ISO standard parameter. The wavelength at which the gain of the phase compensation filter equals 50%.

The input fields ( ) for the cutoff values that correspond to the roughness, primary, and waviness are as mentioned below.

	$\lambda_s$	$\lambda_c$	$\lambda_f$
Roughness profile			-
Primary profile		-	-
Waviness profile			

### 1 Select the cutoff value in [Cutoff] of [Line roughness measurement settings].



You can set each parameter by selecting a value from the dropdown list or typing a value directly.

The minimum value for the  $\lambda_s$  is double of the pixel length, and the maximum value is one half of the profile length in the X axis direction.

The minimum value for the  $\lambda_c/\lambda_f$  is the larger value of either 5 times of the pixel length or 0.025 mm, and the maximum value is the minimum option that is longer than the profile length in the X axis direction.

#### ● Number of sampling length

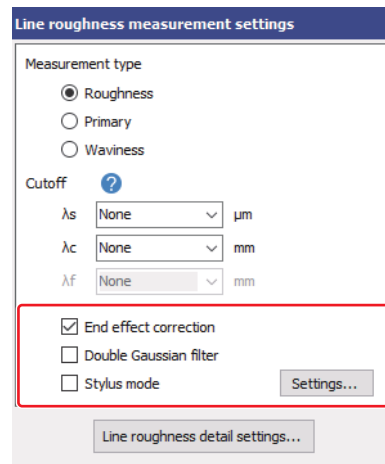
The calculated number of sampling length is displayed according to the cutoff value  $\lambda_c$  for the roughness curve, and according to the cutoff value  $\lambda_f$  for the waviness curve.

However, the number of evaluation length is 1 when the evaluation length is shorter than the cutoff value.

## Setting Filter

Sets the filter to ON/OFF.

### 1 Click the [Double Gaussian filter] checkbox to select ON/OFF.



#### [End effect correction] checkbox

When Double gaussian filter is selected, selecting [End effect correction] checkbox can correct the circumference of the surface so it is not distorted.

#### [Double Gaussian filter] checkbox

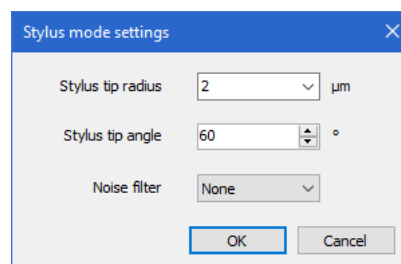
Select this checkbox to enable the filter.

#### [Stylus mode] checkbox

Enables the stylus mode.

#### [Settings] button

Clicking this button displays the [Stylus mode settings] dialog box.



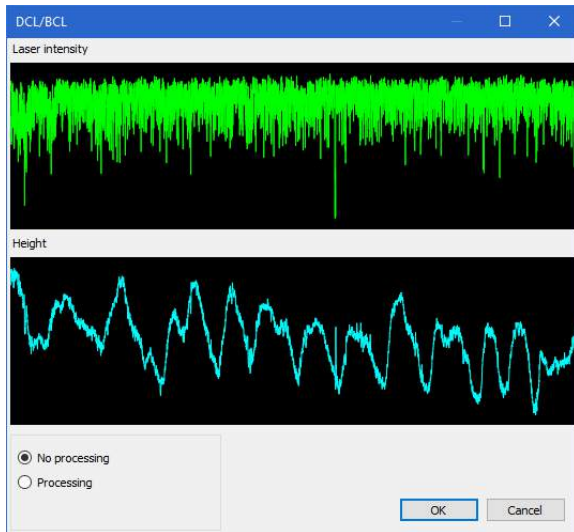
Sets the radius and angle of the stylus tip and the noise filter.

## Correcting the DCL/BCL

DCL (Dark Cut Level)/BCL (Bright Cut Level) cuts the laser intensity level above the dark cut level (lower threshold) or the bright cut level (upper threshold) with the surrounding data when a portion of the laser intensity of the laser intensity profile graph is judged as abnormal (too low or too high).

### 1 Click the [DCL/BCL] button in the profile display area.

The [DCL/BCL] window appears.



### 2 Click the [Processing] radio button.

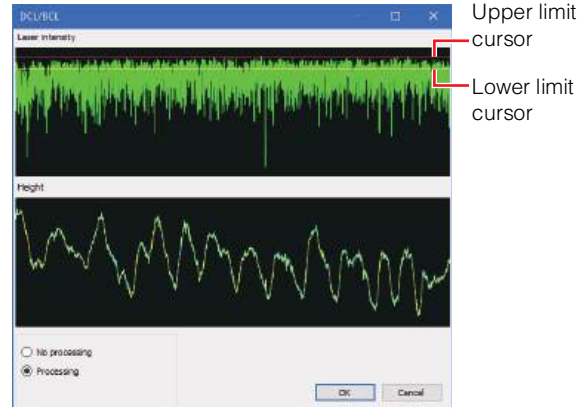
#### [No processing] radio button

The changes in DCL/BCL are not reflected in the display.

#### [Processing] radio button

Smooths height data (cross section Profile) by smoothing and cutting level processing.

### 3 Drag the upper limit and lower limit cursors to set the threshold.



The height profile graph after correction is displayed in the [DCL/BCL] window.

#### Upper limit cursor

The laser intensity data higher than the cursor will be cut (bright areas).

#### Lower limit cursor

The laser intensity data lower than the cursor will be cut (dark areas).

### 4 Click the [OK] button in the [DCL/BCL] window.

This executes the correction.

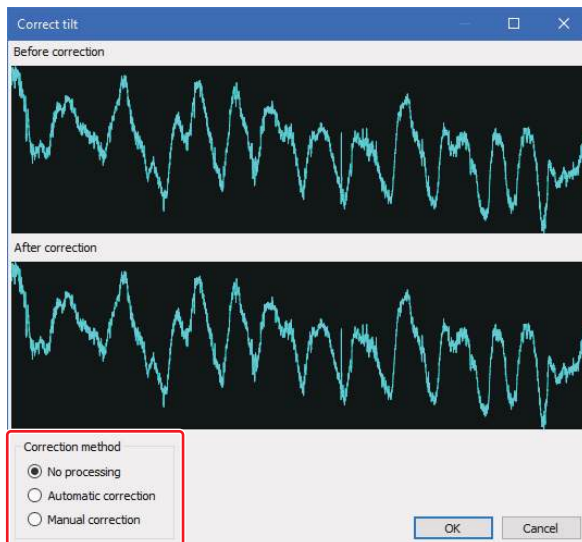
## Correcting the Tilt of Total Profile

Correct the tilt of the profile graph so that the total profile displayed tilted is level.

- Point**
- Corrections are applied only to the total profile of the measurement data. No changes are made to the image that was measured.
  - Correction is set and applied to each profile line.

### 1 Click the [Correct tilt] button in the profile display area.

The [Correct tilt] window appears.



### 2 Select the correction method.

#### [No processing] radio button

Cancels the tilt correction.

#### [Automatic correction] radio button

Performs the tilt correction automatically.

#### [Manual correction] radio button

Performs the tilt correction manually.

### 3 Click the [OK] button in the [Correct tilt] window.

This executes the correction.

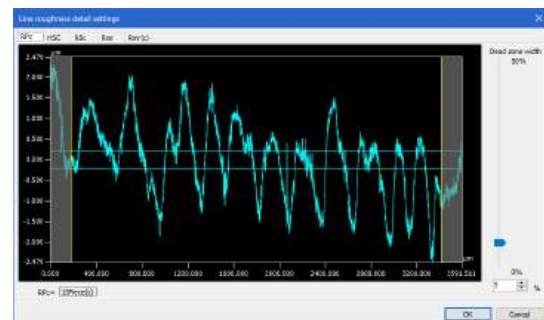
## Line roughness measurement detail settings

When measuring the following parameters, set the threshold values for dead zone width, cut level, etc.

- Peak count
- High spot count
- Cut level difference
- Relative load length ratio
- Load length ratio

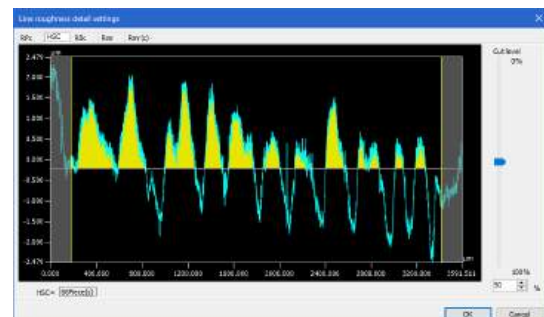
#### ● Peak count

Use the slider to move the two reference lines on the graph and set the dead zone widths (R<sub>Pc</sub>/P<sub>Pc</sub>/W<sub>Pc</sub>) of the roughness, primary and waviness profiles to the range between 0 and 50%.



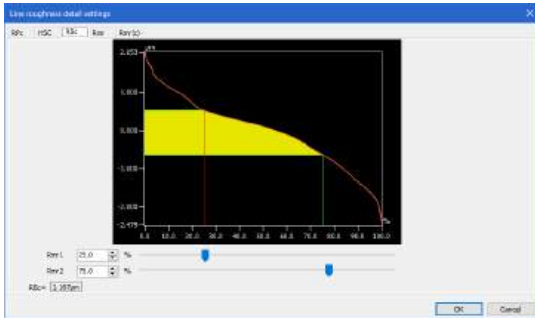
#### ● High spot count

Use the slider to move the reference line indicating the cut level and set the cut levels (HSC) of the roughness, primary and waviness profiles to the range between 0 and 100%.



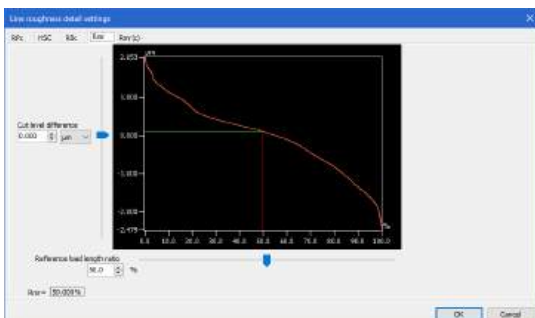
### ● Cut level difference

Use the slider to move the reference lines (Rmr1 and Rmr2) on the graph, and obtain the cut level difference ( $R\delta c/P\delta c/W\delta c$ ) of the roughness, primary and waviness profiles.



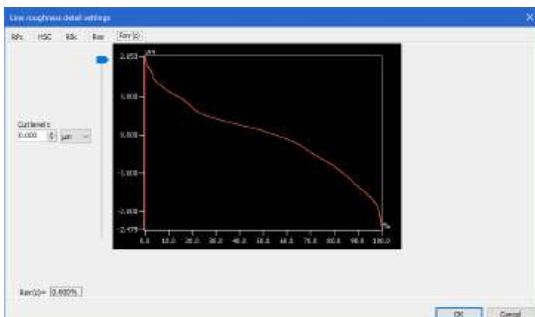
### ● Relative load length ratio

Use the slider to move the reference line indicating the cut level and move the cut level difference or reference load length ratio on the graph, and obtain the cut level difference ( $Rmr/Pmr/Wmr$ ) of the roughness, primary and waviness profiles.



### ● Load length ratio

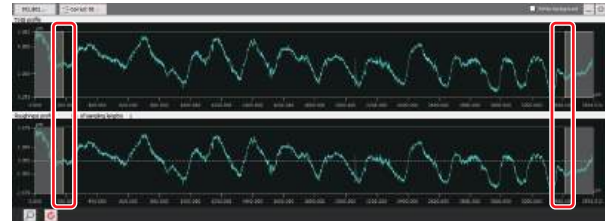
Use the slider to enter the cut level C value or move within the range from 0 to 100%, and obtain the load length ratio ( $Rmr(c)/Pmr(c)/Wmr(c)$ ).



## Setting Evaluation Length

As required, specify an evaluation length on the profile graph. You can set an evaluation length by dragging two yellow vertical cursors that are displayed on the profile graph.

The cursor positions are shared between the roughness/primary/waviness profiles and total profile.



#### Reference

The evaluation length is set automatically, based on the cutoff value  $\lambda_c$  when the measurement type is [Roughness] and the cutoff value  $\lambda_f$  when the measurement type is [Waviness].

For the horizontal direction of the roughness/primary/waviness profiles and total profile, always the whole profiles are displayed fitting to the display area.

By default (right after the profile is updated), both of the roughness/primary/waviness profiles and total profile are displayed fitting to the display area. You can configure the axis setting for the Z axis (vertical axis display of the profile graph).

#### Point


You can specify the range of the Z axis for each of total profile and the roughness/primary/waviness profile individually. However, you cannot operate the X axis.

## 1 Click the (specify value) button in the profile operation controls.

The [Set axis] dialog box appears.

## 2 Set the maximum and minimum values on the Z axis of the desired profile graph, and click the [OK] button.

#### Reference

To restore the Z axis scaling to the original state, click the  (Reset) button.



# Chapter 12

## Surface Roughness Measurement

This chapter describes the surface roughness measurement function found in the [Measurement] menu.

The surface condition wherein uneven surfaces appear in a continuing sequence in relatively short cycles and at relatively shorter intervals than the depth is called surface roughness.

In the surface roughness measurement, surface roughness in the area which is specified optionally on the image is measured.

Flow of Surface Roughness Measurement ...	Page 12-2
Screen Used for Surface Roughness Measurement ..	Page 12-3
Surface Roughness Measurement .....	Page 12-7
Surface Roughness Definitions .....	Page 12-14

# Flow of Surface Roughness Measurement

The flow of surface roughness measurement is as follows:

## Setup

### Selecting measurement data

On the grid sheet, select the measurement data on which you want to perform surface roughness measurement.

Opening/Closing File (Page 3-2)

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Smoothing
- Noise removal
- C-DIC setting
- Leveling
- Height cut level
- Set invalid area
- Auto Position Adjustment
- Surface shape correction
- DCL/BCL
- Screen rotation
- Inverting an image
- Missing data removal
- Image trimming

Chapter 5, Measurement Preprocessing (Page 5-1)

## Measurement

### Displaying the surface roughness measurement window

Display the surface roughness measurement window to perform measurement.

Displaying the Surface Roughness Measurement Window (Page 12-7)

### Setting measurement area

Specify areas in the image display area.

Setting an Area (Page 12-8)

### Performing filter

Set filters to calculate the surface of measurement target.

Setting Filter (Page 12-10)

### Surface roughness measurement detail settings

When measuring the following parameters, set the threshold values for areal material ratio, etc.

- Volume parameters
- Peak extreme height
- Spatial parameters

Surface Roughness Measurement Detail Settings (Page 12-11)

## Post-processing

### Exporting measurement result

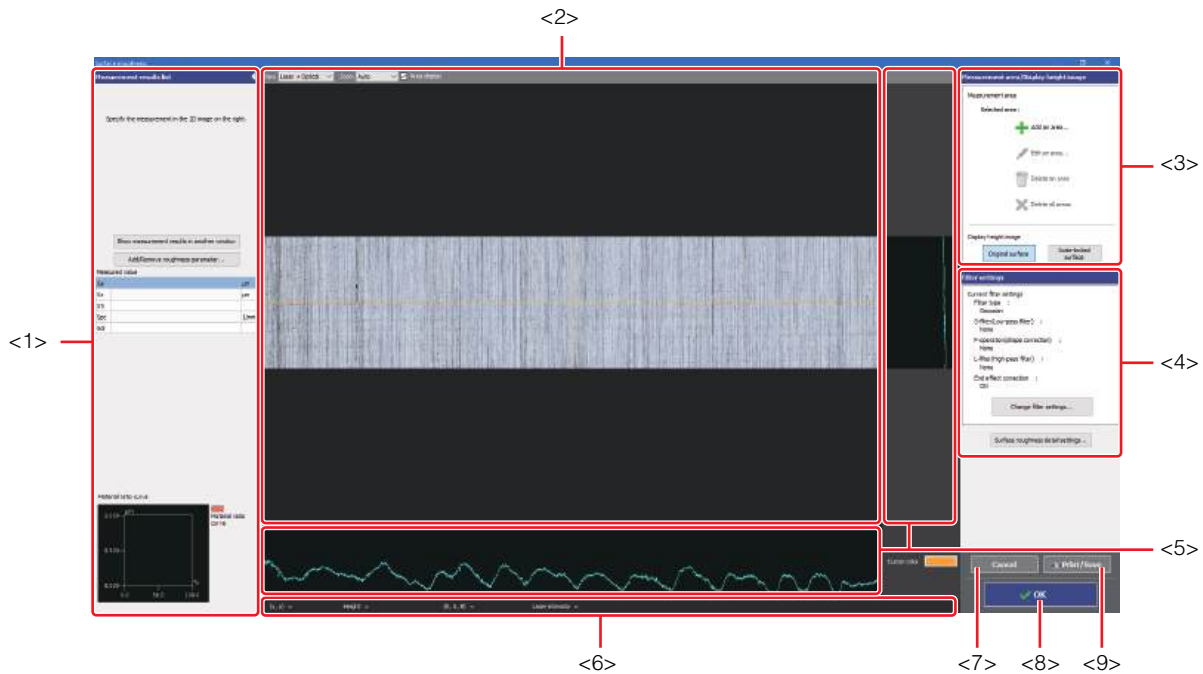
Output the measurement result to Excel file or create a report.

Exporting Measurement Result (Page 12-13)

# Screen Used for Surface Roughness Measurement

Select [Surface roughness measurement] from the [Measurement] menu, or click [Surf R] from the [Roughness] button on the toolbar to display the surface roughness measurement window.

The following describes the name and functions of each part of the surface roughness measurement window.



## <1> Measurement results list

Lists the measurement results obtained from the measurement area specified on the image.

📖 Measurement results list (Page 12-4)

## <2> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. You can also change the display type and magnification of the image.

**Reference** Changing the display type and the magnification of the image can be done using the [View] box and the [Zoom] box respectively displayed on the upper part of image display area.

## <3> Area setting tool

Adds, edits, deletes areas, and switches height image display.

📖 Area Settings Tool (Page 12-5)

## <4> Filter settings

Configures a type of filter, cutoff value and an end effect correction of a filter, and switches height image display.

📖 Surface Roughness Settings (Page 12-6)

## <5> Profile display area

Displays the cross section profile of the sample which is cut perpendicularly to the reference plane at the cursor position in vertical and horizontal directions on the image.

## <6> Status bar

The X and Y coordinates of the mouse placed on the image display area, and the intensity, height and RGB values at the coordinates are displayed.

## <7> [Cancel] button

By clicking, the [Surface roughness] window is closed without applying the setting contents.

## <8> [OK] button

By clicking, the [Surface roughness] window is closed, and the measurement result is applied in the grid sheet.

## <9> [Print/Save] button

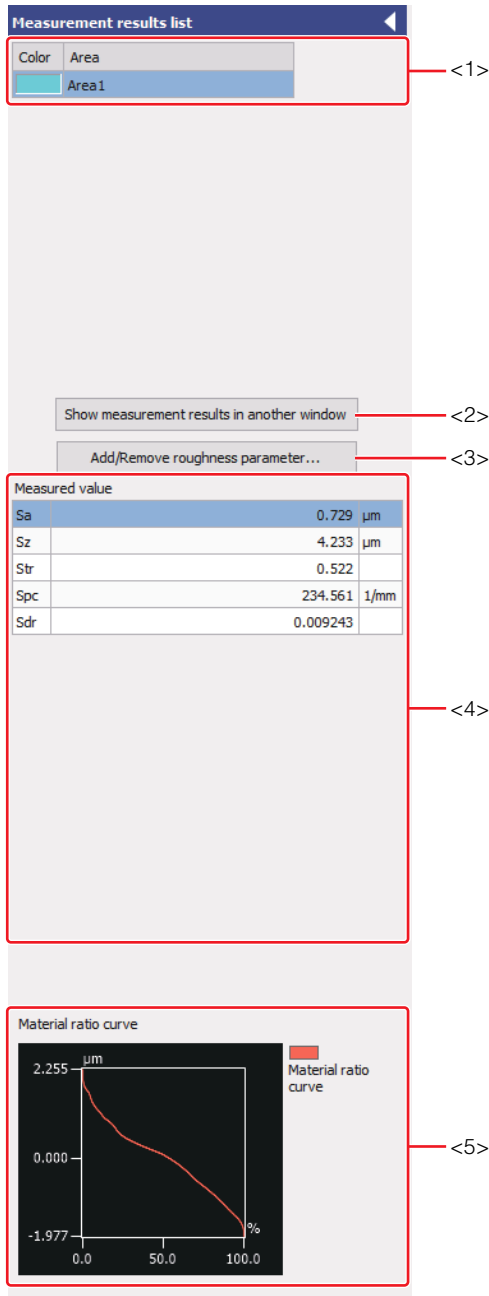
Output the screen display contents in the following formats.

- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

📖 Outputting the Screen Display Contents (Page 6-11)

## Measurement results list

The measurement results list displays the list of the measurement results obtained from the measurement area specified on the image.



**Reference** Click the button to collapse and hide the measurement results list into the left edge of the window. Click the button to display the measurement results list again.

### <1> Measurement results list

Names of each area being set are displayed.  
The currently selected area is highlighted.

### <2> [Show measurement results in another window] button

Displays the result displayed on the measured value in a different window. The displayed result can be saved as a text file in CSV format.

### <3> [Add/Remove roughness parameter...] button

Sets Show or Hide of the roughness parameter displayed on the measured value.

### <4> Measured value

Displays the area name and area rendering color of the selected area. This option also displays the measured values of each parameter of the selected area.

The following items and the measured value list are also displayed for all the areas.

Parameter	Name	Description
Height parameters	Sq	Root mean square height The parameter equivalent to the standard deviation of distance from the average surface. It is equivalent to the standard deviation of height.
	Ssk	Skewness Indicates the symmetric property of the height distribution.
	Sku	Kurtosis Indicates the sharpness of the height distribution.
	Sp	Maximum profile peak height Indicates the height of the highest point from the average surface.
	Sv	Maximum profile valley depth Indicates the absolute value of the height of the lowest point from the average surface.
	Sz	Max. height Indicates the distance from the highest point to the lowest point on the surface.
	Sa	Arithmetical mean height Indicates the average value of the absolute value of height from the average surface.
Spatial parameters	Sal	Autocorrelation length Indicates the horizontal distance of the autocorrelation function with the fastest decay to a certain value s (0.2 by default).
	Str	Texture aspect ratio Indicates the uniformity of the surface texture by taking the horizontal distance (equivalent to Sal) of the autocorrelation function with the fastest decay to a certain values and dividing it by the horizontal distance with the slowest decay to value s.
	Std	Texture direction Indicates a value of the angle s where the angular spectrum fAPS (S) is maximized, which denotes a direction of the crease of surface texture.

Parameter	Name	Description	
Hybrid parameters	Sdq	Root mean square gradient	The parameter calculated from the root mean square of gradient at all the points in definition area.
	Sdr	Developed interfacial area ratio	Indicates how the developed area (surface area) in definition area increases with respect to the area of definition area.
	Spd	Density of peaks	Indicates the number of peaks per unit area.
	Spc	Arithmetic mean peak curvature	Indicates an arithmetic mean value of principal curvatures of peak in definition area.
Functional parameters	Sk	Core height	A value where the core minimum height is subtracted from the core maximum height, which is calculated from a height difference between 0% and 100% of areal material ratio of regression line.
	Spk	Reduced peak height	Indicates an average height of the reduced peak section.
	Svk	Reduced dale height	Indicates an average depth of the reduced dale section.
	Smr1	Upper material ratio	Smr1 and Smr2 refer to the areal material ratio at the intersection of the core's upper-part height and material ratio curve, and the areal material ratio at the intersection of the core's lower-part height and material ratio curve, respectively.
	Smr2	Lower material ratio	
	Sxp	Peak extreme height	A difference in height between one areal material ratio (p%) and the other areal material ratio (q%).
	Functional volume parameters	Vvv	Dale void volume
Vvc		Core void volume	Indicates a difference in void volume between p% and q% of the areal material ratio.
Vmp		Peak material volume	Indicates a material volume when the areal material ratio is p%.
Vmc		Core material volume	Indicates a difference in material volume between q% and p% of the areal material ratio.
Area square measure		The square measure value of the area.	

For details of each measurement item, refer to Surface Roughness Definitions (Page 12-14).

**<5> Material ratio curve**

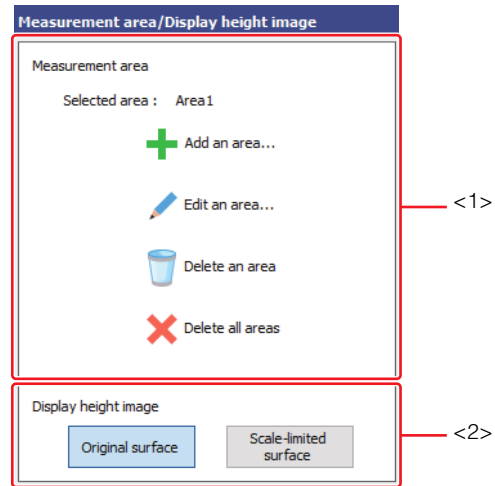
Displays the material ratio curve (BAC).

**Area Settings Tool**

Using the area settings tool, add, edit, and delete areas in the measurement area.

You can also change the cursor color displayed in the image display area.

Setting an Area (Page 12-8)



**<1> [Measurement area]**

**[Add an area] button**

Clicking on this button displays the [Area settings] window.

When you set an area in the [Area settings] window and click the [OK] button, the area is added to the image display area.

**[Edit an area] button**

Clicking on this button displays the [Area settings] window.

When you edit an area in the [Area settings] window, the area displayed in the image display area and the measured values in the measurement results list will be updated.

**[Delete an area] button**

Deletes the selected area.

**[Delete all areas] button**

Deletes all the areas that have been set on the image display area.



To restore the deleted areas, click the [Previously set area] button in the area settings window.

**<2> [Display height image]**

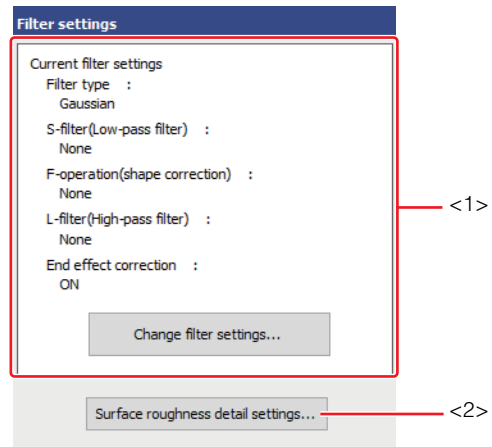
**[Original surface] button**

Switches the image displayed in the image display area to the original surface (usual height image).

**[Scale-limited surface] button**

Switches the image displayed in the image display area to the scale-limited surface (height image of surface that is for measurement, to which the filter is applied).

**Surface Roughness Settings**



**<1> Current filter settings**

Displays the current filter settings. Clicking the [Change filter settings...] button displays the [Filter settings] dialog box, and you can change the filter setting values, and switch Enable/Disable of the end effect correction.

**<2> [Surface roughness detail settings] button**

When measuring the following parameters, set the threshold values for areal material ratio, etc.

- Volume parameters
- Peak extreme height
- Spatial parameters

# Surface Roughness Measurement

## Displaying the Surface Roughness Measurement Window

Display the surface roughness measurement window to perform measurement.

### 1 Open the measurement data or analysis result file.

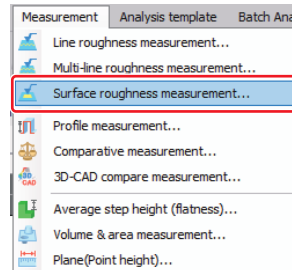
📖 Opening/Closing File (Page 3-2)



Perform the following preprocessing as needed.

- Reference Plane Settings
  - 📖 Reference Plane Settings (Page 5-3)
- Leveling
  - 📖 Leveling (Page 5-9)
- Surface shape correction
  - 📖 Surface Shape Correction (Page 5-11)
- Inverting an Image
  - 📖 Inverting an Image (Page 5-16)
- Smoothing
  - 📖 Smoothing (Page 5-17)
- Height cut level
  - 📖 Height Cut Level (Page 5-19)
- DCL/BCL
  - 📖 DCL/BCL (Page 5-22)
- Missing data removal
  - 📖 Missing Data Removal (Page 5-25)
- Noise removal
  - 📖 Noise Removal (Page 5-26)
- Set invalid area
  - 📖 Set invalid area (Page 5-28)
- Screen rotation
  - 📖 Screen rotation (Page 5-29)
- Image trimming
  - 📖 Image trimming (Page 5-30)
- C-DIC setting
  - 📖 C-DIC setting (Page 5-32)
- Auto Position Adjustment
  - 📖 Auto Position Alignment (Page 5-34)

### 2 Select [Surface roughness measurement] from the [Measurement] menu. Or click the [Surf R] button on the toolbar.

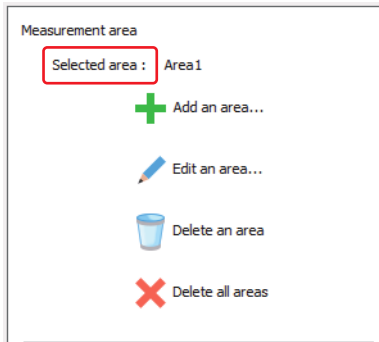


The surface roughness measurement window appears.

## Setting an Area

Set an area at the measurement position on the image displayed in the surface roughness measurement window.

When you set an area, measured values in the area are displayed in the measurement results list.

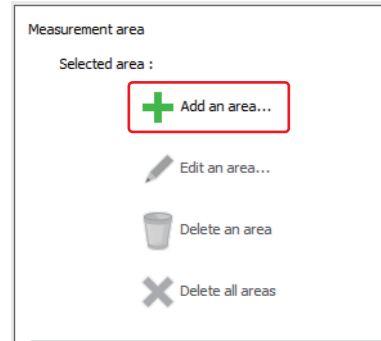


### Point

- When you edit or delete the selected area, make sure the desired area name is displayed in [Selected area].
- By default where no area is set yet, buttons other than the [Add an area] button cannot be clicked. When more than one area are selected, buttons other than the [Add an area] and [Delete all areas] buttons cannot be clicked.

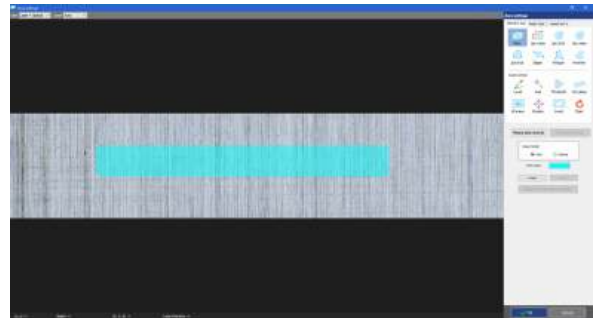
## Adding measurement area

### 1 Click the [Add an area] button.



The [Area settings] window appears.

### 2 Set an area, and click the [OK] button.



The area is set in the image display area.

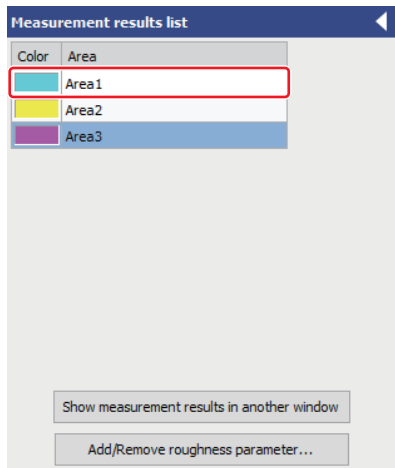
For further information on the area setting procedures, refer to [Area Settings \(Page A-2\)](#).

### Point

Up to 10 areas can be set on the same image.

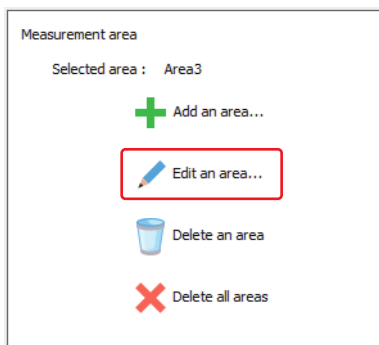
## Editing measurement area

- 1 Select a desired area from the measurement results list.



The name of the selected area is displayed in [Selected area].

- 2 Click the [Edit an area] button.



The [Area settings] window appears.

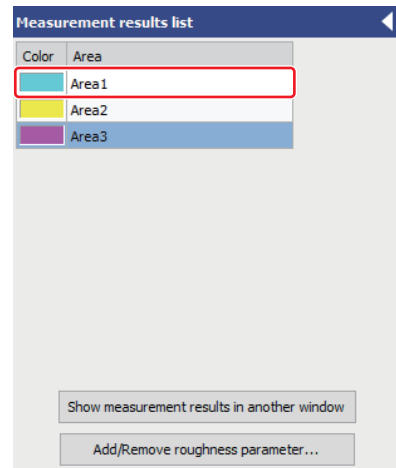
- 3 Edit an area, and click the [OK] button.

The area displayed in the image display area and the measured values in the measurement results list are updated.

For further information on the area setting procedures, refer to Area Settings (Page A-2).

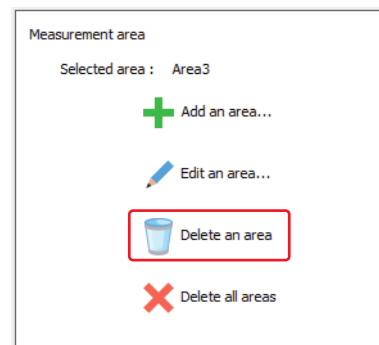
## Deleting measurement area

- 1 Select a desired area from the measurement results list.



The name of the selected area is displayed in [Selected area].

- 2 Click the [Delete an area] button.



The area is deleted from the image display area. The row of the area is also deleted from the measurement results list.

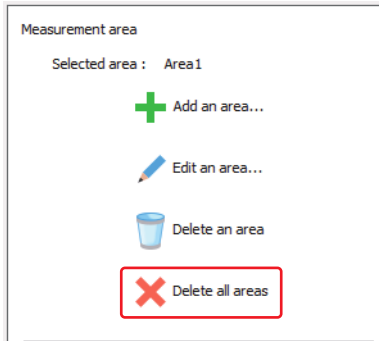


You can also delete an area by doing either of the following when an area is selected:

- Press the Delete key.
- Select [Delete] from the right-click menu.

## Deleting all measurement areas

### 1 Click the [Delete all areas] button.

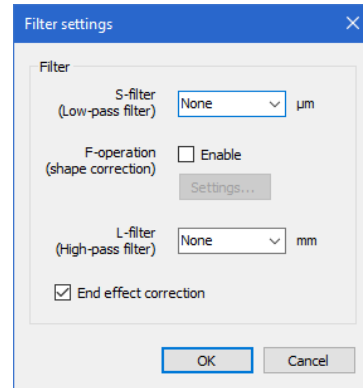


All the areas that have been set are deleted from the image display area.

## Setting Filter

Click the [Change filter settings...] button to change the current filter settings.

The [Filter settings] dialog box appears.



### [S-filter] box

Low-pass filter. Removes components which are small in scale.

### [F-operation] box

Used to remove the shape of surface.

Surface Shape Correction (Page 5-11)

### [L-filter] box

High-pass filter. Removes the long components of waveform of waviness etc.

### [End effect correction] checkbox

When this checkbox is selected, reduce distortion by using the linear Gaussian regression filter in the distorted area.

When this checkbox is cleared, the area is extended with the image pixel data, and then an ordinary Gaussian filter will be applied.

**1** Select the filter setting value in the [S-filter] items.

**2** Select [Enable] checkbox for [F-operation], and press the setting button.

**3** Select the filter setting value in the [L-filter] items.

**4** Enable or disable [End effect correction].

**5** Click the [OK] button.

The filter processing is performed and the measurement values in the measurement results list are updated.

## Surface Roughness Measurement Detail Settings

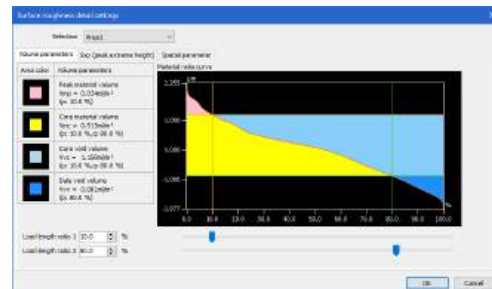
When measuring the following parameters, set the threshold values for load length ratio, area material ratio, etc.

- Volume parameters
- Peak extreme height
- Spatial parameters

### ● Volume parameters

Using the slider, move the load length ratio 1 and load length ratio 2, and then determine the peak material volume  $V_{mp}$ , core material volume  $V_{mc}$ , core void volume  $V_{vc}$  and dale void volume  $V_{vv}$ .

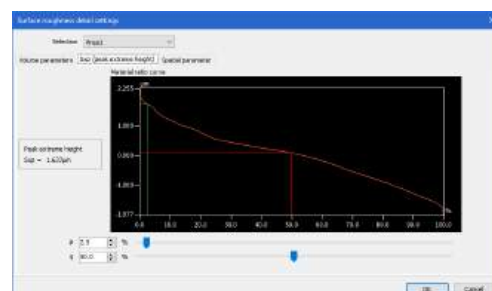
The load length ratio can be set within the range from 0 to 100%.



### ● Peak extreme height

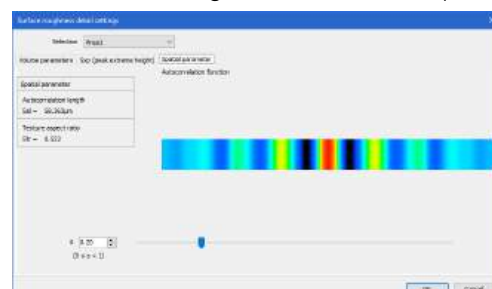
Using the slider, move the reference line that indicates the area material ratio  $p\%$  and area material ratio  $q\%$ . Then, determine the peak extreme height  $S_{xp}$ .

The area material ratio  $p\%$  and area material ratio  $q\%$  can be set within the range from 0 to 100%.



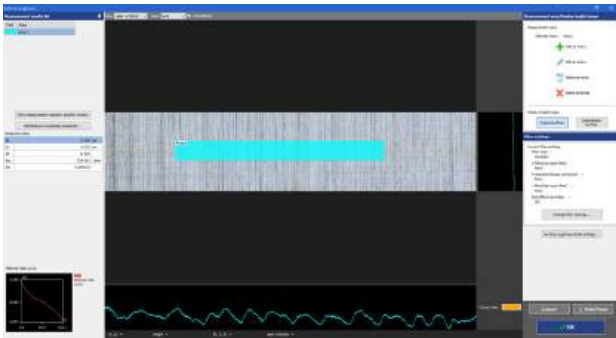
### ● Spatial parameters

Using the slider, change the attenuation value  $S$  of the autocorrelation function, and then determine the autocorrelation length  $S_{al}$  and texture aspect ratio  $S_{tr}$ .



## Displaying measurement results

When filtering is executed, measurement results in the measurement results list are updated.



**Reference**

- You can change the order of the rows in the table by dragging an area name.
- You can change the area rendering color by clicking the color palette of [Color].
- You can change an area name by clicking the area name of the selected area or selecting [Rename] from the right-click menu.

The following items and the measured value list are updated for all the areas.

Parameter		Name
Sq	Height	Root mean square height
Ssk	Parameter	Skewness
Sku		Kurtosis
Sp		Maximum profile peak height
Sv		Maximum profile valley depth
Sz		Max. height
Sa		Arithmetical mean height
Sal	Spatial	Autocorrelation length
Str	Parameter	Texture aspect ratio
Std		Texture direction
Sdq	Hybrid	Root mean square gradient
Sdr	Parameter	Developed interfacial area ratio
Spd		Density of peaks
Spc		Arithmetic mean peak curvature
Sk	Function	Core height
Spk	Parameter	Reduced peak height
Svk		Reduced dale height
Smr1		Upper material ratio
Smr2		Lower material ratio
Sxp		Peak extreme height

Parameter		Name
Vvv	Functional volume	Dale void volume
Vvc		Core void volume
Vmp	Parameter	Peak material volume
Vmc		Core material volume
Area square measure		The square measure value of the area

For details of each parameter, refer to Surface Roughness Definitions (Page 12-14).

## Filter operation

In the surface roughness measurement, filtering is executed using the Gaussian filter.

When you execute filtering, filtering is processed in the order of S-filter and L-filter against the entire image. After the filtering is completed, the measurement results list will be updated.

**Point**

When the Gaussian filter is applied to an image, the margins (the area half of the cutoff wavelength distance away from the edge) will be distorted, therefore either set the area avoiding the margins, or turn on the [End effect correction] checkbox.

### ● S-filter

This filter removes roughness components which are small in scale like optical resolution (low-pass filter).

Set the S-filter to a value that is 3 times of the measurement resolution in XY-plane or more. When the effect is not sufficient, set a larger value.

The minimum cutoff wavelength of S-filter is double of the pixel length, and the maximum cutoff wavelength is one half of the length of the longer side of the image.

### ● L-filter

This filter removes waviness components which are large in scale (high-pass filter).

Set the L-filter to a value that is 5 times of the cycle length of shapes you want to remove as waviness.

The minimum cutoff wavelength of L-filter is 100 times of the pixel length, and the maximum cutoff wavelength is the wavelength of the first option that is longer than the longer side length of the image.

## Applying the Measurement Result in the Main Screen

### 1 Click the [OK] button in the [Surface roughness] window.

The [Surface roughness] window is closed, and the measurement result is applied in the grid sheet.



By clicking the [Cancel] button, the [Surface roughness] window is closed without applying the setting contents.

## Operating the Grid View Area

Measurement data information and measurement analysis results are displayed on the grid view area. For setting the display contents, see the following.

- Grid view area (Page 2-8)
- Inserting items (Page 2-11)
- Sorting (Page 2-12)

## Exporting Measurement Result

The measurement result of the surface roughness measurement can be output to a report or Excel file.

### ● Report output

Outputs the results in a defined format in another window.

Refer to Report (Page 3-9).



### ● Exporting to Excel file

Outputs the image data and text to Excel in grid display layout.

Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to Exporting as Excel File (Page 3-15).

### ● Save CSV

Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

Refer to Exporting measurement result (Page 3-13).

# Surface Roughness Definitions

## ISO 25178 Surface Texture Definitions

This software determines 24 types of parameters specified by the surface texture parameter (ISO 25178-2:2012), which are classified into the following 5 categories.

Height parameters		
Sq	Root mean square height	root mean square height
Ssk	Skewness	skewness
Sku	Kurtosis	kurtosis
Sp	Maximum profile peak height	maximum peak height
Sv	Maximum profile valley depth	maximum pit height
Sz	Max. height	maximum height
Sa	Arithmetical mean height	arithmetical mean height
Spatial parameters		
Sal	Autocorrelation length	autocorrelation length
Str	Texture aspect ratio	texture aspect ratio
Std	Texture direction	texture direction
Hybrid parameters		
Sdq	Root mean square gradient	root mean square gradient
Sdr	Developed interfacial area ratio	developed interfacial area ratio
Spd	Density of peaks	density of peaks
Spc	Arithmetic mean peak curvature	arithmetic mean peak curvature
Functional parameters		
Sk	Core height	core height
Spk	Reduced peak height	reduced peak height
Svk	Reduced dale height	reduced dale height
Smr1	Upper material ratio	upper material ratio
Smr2	Lower material ratio	lower material ratio
Sxp	Peak extreme height	peak extreme height
Functional volume parameters		
Vv	Dale void volume	dale void volume
Vvc	Core void volume	core void volume
Vmp	Peak material volume	peak material volume
Vmc	Core material volume	core material volume



This software uses the April 2012 version of surface texture parameters (ISO 25178-2:2012). Each of the parameters may be subject to change due to a revision of specifications.

## Definitions of Terms

### ■ Filter operation

Multifile Analyzer Software sets the filter to the entire image, and then sets the area to take a measurement. Frequency filter at this time is different for each category.



When the Gaussian filter is applied to an image, the margins (the area half of the cutoff wavelength distance away from the edge) will be distorted, therefore, either set the area avoiding the margins, or turn on the [End effect correction] setting.

### ● Gaussian filter

This is the Gaussian filter specified by JISB0632:2001 (ISO 11562:1996) and ISO 16610-21:2011 whose surface area has been extended.

### ■ End effect correction

In the Gaussian filter, this option prevents a distortion from occurring in any shape of the surface periphery of image (the area half of the cutoff wavelength distance away from the edge). The larger the cutoff frequency, the longer the processing time.

### ■ Original surface

This surface refers to the surface consisting of height data at the start-up time of ISO 25178 surface roughness function.

### ■ Scale-limited surface

This represents a surface obtained by applying the S-filter and L-filter to the original surface.

### ■ S-filter

This is the filter (low-pass filter) to remove components which are small in scale.

This filter is equivalent to the cutoff value  $\lambda_s$  of JIS B0601-2001. It refers to a low-pass filter for a frequency filter such as a Gaussian filter.

### ■ L-filter

This is the filter (high-pass filter) to remove components which are large in scale.

This filter removes components such as waviness and extracts only roughness components. This is equivalent to the cutoff value  $\lambda_c$  of JIS B0633-2001. It refers to a high-pass filter for a frequency filter such as a Gaussian filter.

### ■ Height

It refers to a distance from the reference surface at each point in a scale-limited surface. Points lower than the reference surface will have negative values. In the definitional equation, the height in coordinates (x, y) is expressed by z (x, y).

### ■ Surface filter

This filter represents the filter processing applied to surface.

### ■ Primary surface

This represents a surface obtained by applying the S-filter to original surface.

### ■ F-Operation

This refers to the processing to remove shape from the primary surface.

### ■ S-F surface

This represents a surface obtained by applying the F-operation to the primary surface.

### ■ S-L surface

This represents a surface obtained by applying the L-filter to the S-F surface.

### ■ Evaluation area

Of all the scale-limited surfaces, this area refers to a portion subject to evaluation.

### ■ Definition area

Of all the evaluation areas, this area refers to a portion to be used for defining parameters. In the definitional equation, it is expressed by A.

### ■ Reference surface

It serves as the reference surface corresponding to the scale-limited surface, which refers to the plane surface at average height in evaluation area for the ISO 25178 surface texture function.

### ■ nesting index

It denotes a concept equivalent to wavelength in surface profile. The definition of wavelength applies to the linear filters, such as Gaussian filter.

## Height parameters

The height parameters are the parameters concerned only with change in height.

### ■ Sq Root mean square height

It is the root mean square of height at each point in definition area. It is equivalent to the standard deviation of height.

$$S_q = \sqrt{\frac{1}{A} \iint_A z^2(x, y) dx dy}$$

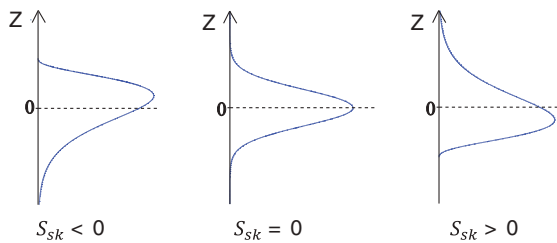
### ■ Ssk Skewness

It is the cubic average of height which is rendered dimensionless with the cube of Sq. It indicates the asymmetric property of height distribution which is centered on the reference surface.

When Ssk equals 0, it means that the height distribution is symmetric with respect to the reference plane.

While  $S_{sk} < 0$ ,  $S_{sk} > 0$ , it means that the height distribution is skewed to either upside or downside related to the reference plane.

$$S_{sk} = \frac{1}{S_q^3} \left[ \frac{1}{A} \iint_A z^3(x, y) dx dy \right]$$



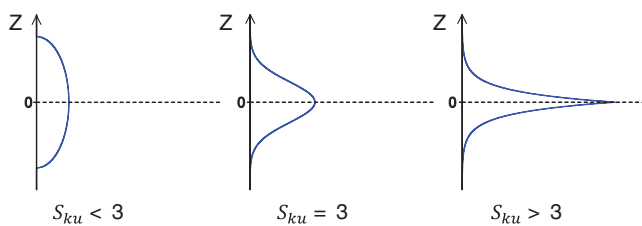
### ■ Sku Kurtosis

It is the average fourth power of height which is rendered dimensionless with the fourth power of Sq. Indicates the sharpness of the height distribution.

When Sku equals 3, it means that the height distribution of scale-limited surface is a normal distribution.

While  $S_{ku} < 3$ ,  $S_{ku} > 3$ , it means that the height distribution takes either collapsed or sharpened shape.

$$S_{ku} = \frac{1}{S_q^4} \left[ \frac{1}{A} \iint_A z^4(x, y) dx dy \right]$$



### ■ Sp Maximum peak height

It is the height of the highest point in definition area.

$$S_p = \max_A z(x, y)$$

### ■ Sv Maximum valley depth

It is the absolute value of height of the lowest point in definition area.

$$S_v = |\min_A z(x, y)|$$

### ■ Sz Maximum height

It is a sum of the maximum peak height and the maximum valley depth in definition area.

$$S_z = S_p + S_v$$

### ■ Sa Arithmetical mean height

It is the average value of the absolute value of height at each point in definition area.

$$S_a = \frac{1}{A} \iint_A |z(x, y)| dx dy$$

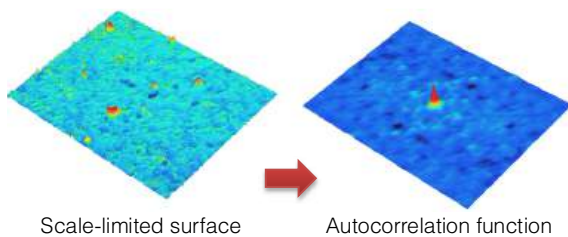
## Spatial parameters

The spatial parameters are the parameters concerned with the plane (wavelength) direction.

### ■ Autocorrelation function

The autocorrelation function  $f_{ACF}$  is defined as follows.

$$f_{ACF}(t_x, t_y) = \frac{\iint_A z(x, y)z(x-t_x, y-t_y)dx dy}{\iint_A z(x, y)z(x, y)dx dy}$$



### ● Sal Autocorrelation length

Indicates the horizontal distance of the autocorrelation function with the fastest decay to a certain value  $s$  (0.2 by default).

In the surface (anisotropic surface) having a certain orientation, this Sal can be obtained from a direction perpendicular to the surface crease.

The Sal of higher value indicates that larger nesting index component (long-wavelength component) is dominant, whereas the Sal of lower value indicates that smaller nesting index component (short-wavelength complement) is dominant.

$$S_{al} = \min_{t_x, t_y \in R} \sqrt{t_x^2 + t_y^2} \text{ where } R = \{(t_x, t_y): f_{ACF}(t_x, t_y) \leq s\}$$

### ● Str Texture aspect ratio

Indicates the uniformity of the surface texture by taking the horizontal distance (equivalent to Sal) of the autocorrelation function with the fastest decay to a certain value and dividing it by the horizontal distance with the slowest decay to value  $s$ .

Str takes a value of the section (between 0 and 1).

A larger value (Str > 0.5) means that a uniform surface texture (isotropic surface) is formed in all directions. For example, this value increases for such a surface that does not have a certain crease, as seen in the surface to which electrical discharge machining (EDM) is applied.

Conversely, a smaller value (Str < 0.3) means that the surface is of surface texture (anisotropic surface) having a certain orientation.

However, an anisotropic surface may not reach the values by using the autocorrelation function with the slowest decay because the evaluation area is limited to a finite range.

$$S_w = \frac{\min_{t_x, t_y \in R} \sqrt{t_x^2 + t_y^2}}{\max_{t_x, t_y \in Q} \sqrt{t_x^2 + t_y^2}} \text{ where } R = \{(t_x, t_y): f_{ACF}(t_x, t_y) \leq s\}$$

$$Q = \{(t_x, t_y): f_{ACF}(t_x, t_y) \geq s \text{ and } **\}$$

Where \*\* is the property that the  $f_{ACF} \geq s$  on the straight line connecting the point  $(t_x, t_y)$  to the origin.

### ■ Angular spectrum

The angular spectrum  $f_{APS}(s)$  is an integrated value at the angle  $s$  based on the angle  $\theta$  of 2D power spectrum on the surface, which is defined as below.

$$f_{APS}(s) = \int_{R_1}^{R_2} r |F[r \sin(s-\theta), r \cos(s-\theta)]|^2 dr$$

Where the range from  $R_1$  to  $R_2$  is an integral range in a moving radius direction.  $F(p, q)$  is the Fourier transform as defined below.

$$F(p, q) = \iint_A z(x, y) e^{-i(px+ipy)} dx dy$$

For angle, the positive X axis is 0 degrees, and the counter clockwise direction is a positive direction.

In the ISO 25178 surface texture measurement,  $\theta$  is fixed at 0 degrees.

### ● Std Texture direction

Indicates a value of the angle  $s$  where the angular spectrum  $f_{APS}(s)$  is maximized, which denotes a direction of the crease of surface texture.

Note, however, that no significant value can be obtained on the isotropic surface where Str is greater than 0.5.

\*According to ISO 25178-2:2012, they are classified into miscellaneous parameters.

## Hybrid parameters

The hybrid parameters are the parameters concerned with both the height direction and plane (wavelength) direction.

### ● Sdq Root mean square gradient

This is calculated from the root mean square of gradient at all the points in definition area.

It is used as a reference for gradient components that constitute a surface, and can also be used for identifying surface profile having a similar arithmetical mean height  $S_a$ . In the event that there are two surfaces having the identical  $S_a$  value, one Sdq value of the surface which consists of relatively large nesting index (long-wavelength component) becomes smaller, while the other Sdq value of the same which consists of smaller nesting index (short-wavelength component) becomes larger.

$$S_{dq} = \sqrt{\frac{1}{A} \iint_A \left[ \left( \frac{\partial z(x, y)}{\partial x} \right)^2 + \left( \frac{\partial z(x, y)}{\partial y} \right)^2 \right] dx dy}$$

### ● Sdr Developed interfacial area ratio

Indicates how the developed area (surface area) in definition area increases with respect to the area of definition area. It is expressed by a ratio of area to definition area. It will be 0 if the surface is a completely flat surface which is perpendicular to the orientation of the height.

Sdr varies depending on both the components in height and plane (wavelength) directions. The resultant value increases as the amplitude increases in the height direction and as the nesting index (wavelength) decreases in the horizontal direction.

$$S_{dr} = \frac{1}{A} \iint_A \left[ \sqrt{1 + \left( \frac{\partial z(x, y)}{\partial x} \right)^2 + \left( \frac{\partial z(x, y)}{\partial y} \right)^2} - 1 \right] dx dy$$

### ■ Peak

Means a higher point than any other adjacent points in surrounding area on the surface.

### ● Spd Density of peaks

Indicates the number of peaks per unit area.

### ● Spc Arithmetic mean peak curvature

Indicates an arithmetic mean value of principal curvatures of peak in definition area.

$$S_{pc} = -\frac{1}{2} \frac{1}{n} \sum_{k=1}^n \left( \frac{\partial^2 z(x, y)}{\partial x^2} + \frac{\partial^2 z(x, y)}{\partial y^2} \right)$$

Reference

In ISO 25178-2: 2012 this is categorized as a Feature parameter.

In ISO 25178-2: 2012, Wofst pruning is prescribed for merging the peaks of micro hill areas with adjoining areas for preprocessing.

However, this process cannot be executed with this software.

## Functional parameters

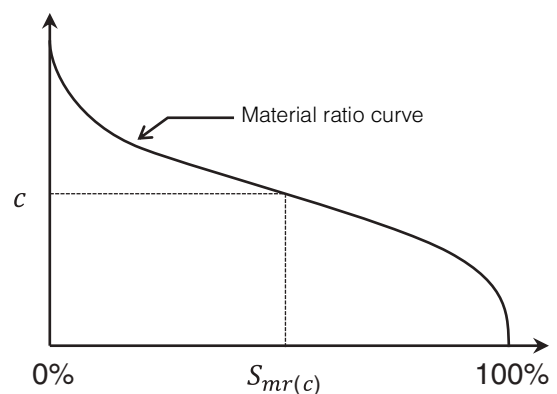
The functional parameters are the parameters based on which calculation is made using a material ratio curve. They are used to evaluate behavior of a surface which remains strongly in contact with something in a mechanical fashion.

### ■ Areal material ratio

A percentage of areal material (area of a region at a height of  $c$  or higher) at a certain height  $c$  is called the areal material ratio,  $S_{mr}(c)$ .

### ■ Areal material ratio curve/Bearing area curve/Abbot Firestone curve

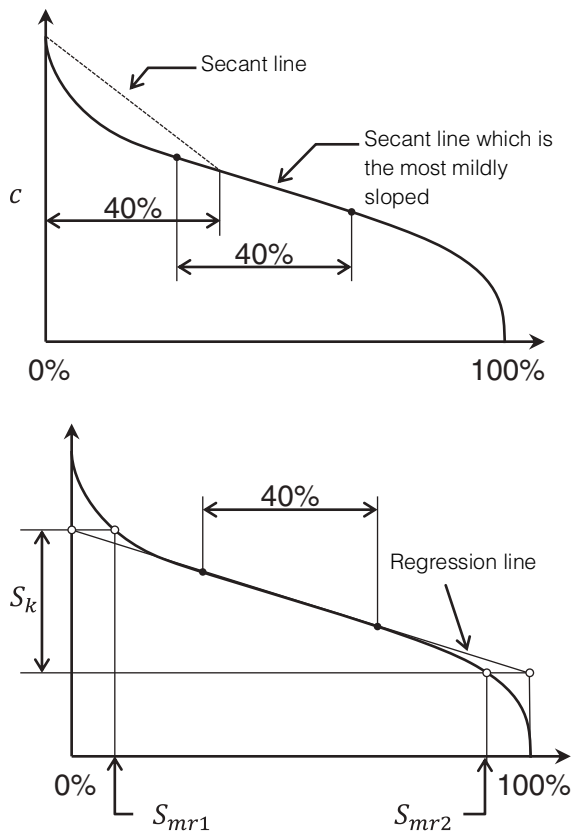
A curve that indicates a height where the areal material ratio becomes 0% to 100% is called the material ratio curve.



## ■ Regression line

Draw a secant line between 0% of the areal material ratio and 40% of the areal material ratio, and move the secant line from the 0% of the the areal material ratio to the position where the secant line is the most mildly sloped. This is the central part of material ratio curve.

A straight line on which a square sum of deviation in the vertical axis direction is reduced to a minimum with respect to this central part is called the regression line.



## ■ Core surface

The core surface is the surface where a region which is not included in the range from 0% to 100% of areal material ratio of regression line is removed from the definition area of scale-limited surface.

In addition, the area that protrudes upward from the core surface and the area that sinks downward from the same are called the reduced peak section and the reduced dale section, respectively.

### ● Sk Core height

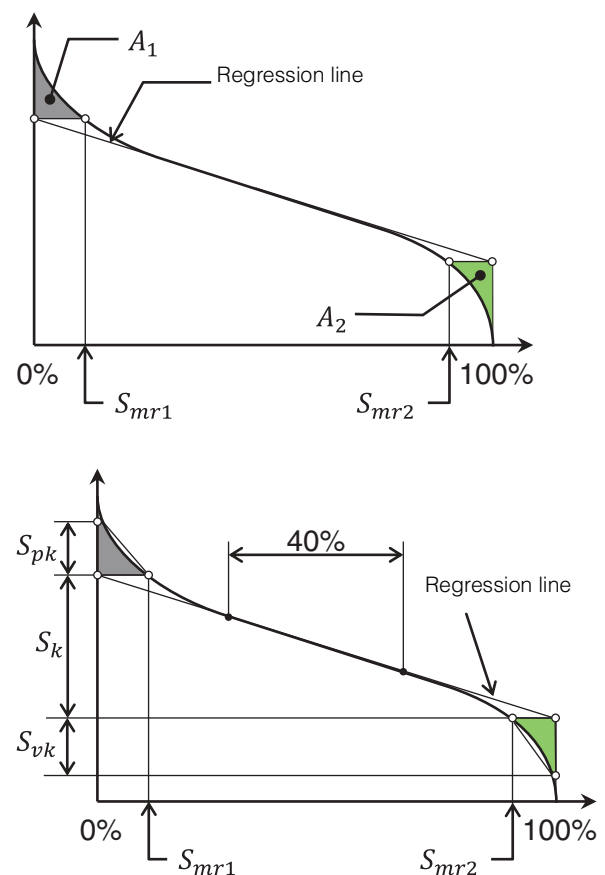
A value where the core minimum height is subtracted from the core maximum height, which is calculated from a height difference between 0% and 100% of areal material ratio of regression line.

### ● Spk Reduced peak height

### ● Svk Reduced dale height

Spk is an average height of the reduced peak section, and Svk is an average depth of the reduced dale section.

Spk and Svk are separately given by a height of the right-angled triangle whose area becomes equivalent to the region A1 surrounded by the core's upper-part height and the material ratio curve and to the region A2 surrounded by the core's lower-part height and the material ratio curve. The base of a right-angled triangle whose area is equivalent to A1's area is the intersection (Smr1) of the core's upper-part height and the material ratio curve, while the base of a right-angled triangle whose area is equivalent to A2's area is 100% difference from the intersection (Smr2) of the core's lower-part height and the material ratio curve.



### ● Smr1 Upper material ratio

### ● Smr2 Lower material ratio

Smr1 and Smr2 refer to the areal material ratio at the intersection of the core's upper-part height and material ratio curve, and the areal material ratio at the intersection of the core's lower-part height and material ratio curve, respectively.

### ● Sxp Peak extreme height

A difference in height between one areal material ratio (p%) and the other areal material ratio (q%).

By default,  $p = 2.5\%$  and  $q = 50\%$  are specified.

## Functional volume parameters

The functional volume parameters are the parameters related to volume which are calculated using a material ratio curve. They are used to evaluate behavior of a surface which remains strongly in contact with something in a mechanical fashion.

### ■ Inverse areal material ratio

The inverse areal material ratio,  $S_{mc}(p)$ , represents the height  $c$  which meets the areal material ratio,  $p\%$ .

### ■ Void volume

The void volume,  $V_v(p)$ , indicates a volume of open space per unit area, which is calculated from a material ratio curve of  $p\%$  to  $100\%$  of the areal material ratio.

$$V_{v(p)} = \frac{K}{100\%} \int_p^{100\%} [S_{mc(p)} - S_{mc(q)}] dq$$

Where  $K$  is a constant for unit conversion into  $ml/mm^2$ .

### ■ Material volume

The material volume,  $V_m(p)$ , indicates a volume of actual substance per unit area, which is calculated from a material ratio curve of  $0\%$  to  $p\%$  of the areal material ratio.

$$V_{m(p)} = \frac{K}{100\%} \int_0^p [S_{mc(q)} - S_{mc(p)}] dq$$

Where  $K$  is a constant for unit conversion into  $ml/mm^2$ .

### ● Vvv Dale void volume

Indicates a dale void volume when the areal material ratio is  $p\%$ . By default,  $p = 80\%$  is specified.

$$V_{vv} = V_{v(p)}$$

### ● Vvc Core void volume

Indicates a difference in void volume between  $p\%$  and  $q\%$  of the areal material ratio. By default,  $p = 10\%$  and  $q = 80\%$  are specified.

$$V_{vc} = V_{v(p)} - V_{v(q)}$$

### ● Vmp Peak material volume

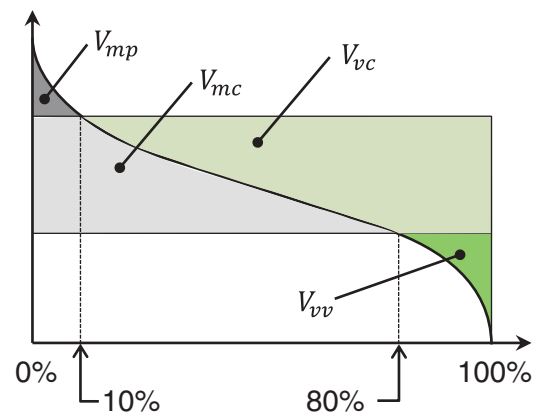
Indicates a material volume when the areal material ratio is  $p\%$ . By default,  $p = 10\%$  is specified.

$$V_{mp} = V_{m(p)}$$

### ● Vmc Core material volume

Indicates a difference in material volume between  $q\%$  and  $p\%$  of the areal material ratio. By default,  $p = 10\%$  and  $q = 80\%$  are specified.

$$V_{mc} = V_{m(q)} - V_{m(p)}$$



# Chapter 13

## Film Thickness Measurement

This chapter describes the line film thickness, surface film thickness, and spectral film thickness measurement functions found on the [Measurement] menu.

Flow of Laser Film Thickness Measurement (Line Film Thickness Measurement) .....	Page 13-2
Screen Used for Line Film Thickness Measurement .....	Page 13-3
Laser Film Thickness Measurement (Line Film Thickness Measurement) .....	Page 13-8
Flow of Laser Film Thickness Measurement (Surface Film Thickness Measurement) ..	Page 13-13
Screen Used for Surface Film Thickness Measurement .....	Page 13-14
Laser Film Thickness Measurement (Surface Film Thickness Measurement) ..	Page 13-18
Flow of Spectral Film Thickness Measurement .....	Page 13-24
Screen Used for Spectral Film Thickness Measurement .....	Page 13-25
Spectral Film Thickness Measurement ....	Page 13-29

# Flow of Laser Film Thickness Measurement (Line Film Thickness Measurement)

The flow of laser film thickness measurement (line film thickness measurement) is as follows:

## Setup

### Selecting measurement data

On the grid sheet, select the measurement data on which you want to perform line roughness measurement.

📖 Opening/Closing File (Page 3-2)



## Measurement

### Displaying the line film thickness measurement window

▼ Display the line film thickness measurement window to perform measurement/analysis.

📖 Displaying the Line Film Thickness Measurement Window (Page 13-8)

### Specifying the measurement point

▼ Drag the Z-I graph of the laser intensity/peak position image display area to the point where you wish to measure the reflection layer.

📖 Setting Measurement Points (Page 13-8)

### Entering the correction coefficient

▼ Enter the refraction index of each layer of transparent target.

📖 Entering Correction Coefficient (Page 13-9)

### DCL display mode

#### Smoothing, DCL

▼ Enter the smoothing coefficient for smoothing and the cut laser intensity level for DCL.

📖 Entering Smoothing and DCL (Page 13-9)

### Inter-layer adj.mode

#### Configuring Peak Position View

▼ Select whether to set the peak position display automatically or manually. For manual setting, set the parameters to display the peak position.

📖 Setting Peak Position Display in Inter-layer Adjustment Mode (Page 13-12)

### Measuring Film Thickness

Switches the image display format of the laser intensity/peak position image display area from laser intensity to peak position.

Move the cursor in the Z-I graph to the peak of the laser intensity data, and measure the film thickness at the peak position.

📖 Measuring Film Thickness (Page 13-10)



## Post-processing

### Exporting measurement result

Output the measurement result to Excel file or create a report.

📖 Exporting Measurement Result (Page 13-11)

This section describes the operating procedures in the DCL display mode.

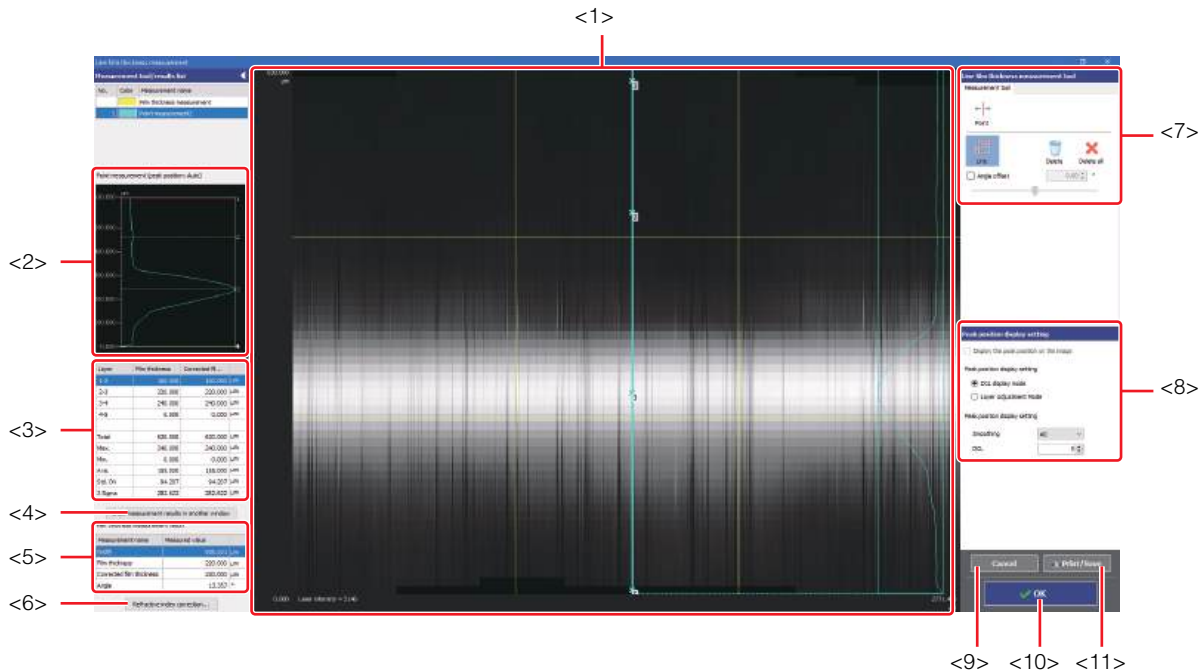
For the inter-layer adj.mode, only the operating procedures for "Configuring Peak Position View" are explained here.

📖 Setting Peak Position Display in Inter-layer Adjustment Mode (Page 13-12)

# Screen Used for Line Film Thickness Measurement

In line film thickness measurement, the film thickness of a transparent target is measured based on the laser intensity cross section data on a measurement line specified on the Viewer Software screen.

The laser intensity section data refer to the laser intensity data representing the front and back surfaces of a transparent target and the boundary surface of the intermediate layer, based on the laser reflection intensity. The film thickness of any part of a transparent target can be measured by measuring the distance between the laser intensity peaks of each layer.



## <1> Laser intensity/peak position image display area

The laser intensity cross section data measured using the Viewer Software are displayed. The white part of the image represents the reflective surface of each detected layer. The Z-I graph and the horizontal and vertical cursors are overlaid on this image.

Laser Intensity/Peak Position Image Display Area (Page 13-4)

## <2> Z-I graph of point measurement

The peak waveform at the measurement point specified in the laser intensity/peak position image display area.

Z-I Graph of Point Measurement (Page 13-5)

## <3> Point measurement results display area

The results of line film thickness measurement in the point measurement are displayed.

## <4> [Show measurement results in another window] button

Displays the result displayed on the measured value in a different window. The displayed result can be saved as a text file in CSV format.

## <5> Film thickness measurement results display area

The measurement results between two points consisting of horizontal and vertical cursors on the image above are displayed.

## <6> [Refractive index correction] button

If a transparent target has multiple layers and each layer has a different refractive index, enter the refractive index of each layer to compensate for errors in the measurement values.

Screen Used for Correction Coefficient Settings (Page 13-5)

## <7> Line film thickness measurement tool

Contains buttons to perform measurements and boxes/sliders to configure the cursor angles.

Line Film Thickness Measurement Tool (Page 13-6)

## <8> Peak position view setting

Contains boxes, etc. for switching and configuring the peak position display mode.

Screens Used in Peak Position View Setting (DCL Display Mode) (Page 13-6)

Screens Used in Peak Position View Setting (Inter-layer Adjustment Mode) (Page 13-7)

**<9> [Cancel] button**

By clicking, the [Line film thickness measurement] window is closed without applying the setting contents.

**<10> [OK] button**

By clicking, the [Line film thickness measurement] window is closed, and the measurement result is applied in the grid sheet

**<11> [Print/Save] button**

Output the screen display contents in the following formats.

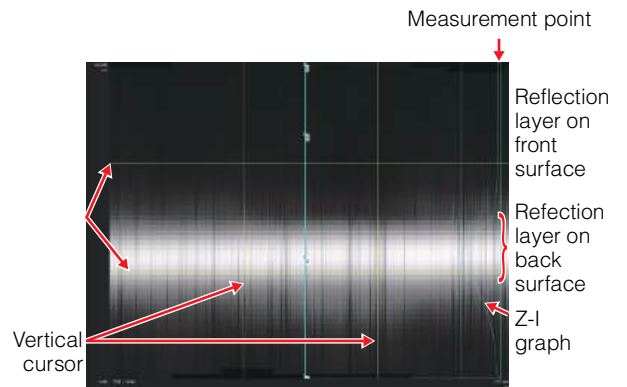
- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

**Laser Intensity/Peak Position Image Display Area**

The laser intensity cross section data measured using the Viewer Software are displayed in the laser intensity/peak position image display area. The white part of the image represents the reflective surface of each detected layer.

The following elements are overlaid on this image:

- Z-I graph  
Displays a graph showing the reflected laser intensity of each layer at the measurement point. Specify the film thickness measurement point by moving the [Point] tool left and right.
- Horizontal and vertical cursors  
The film thickness between two layers can be measured by aligning the upper and lower horizontal cursors with the peak waveform of the Z-I graph. The width between measurement points can be measured by specifying measurement points with the left and right vertical cursors.

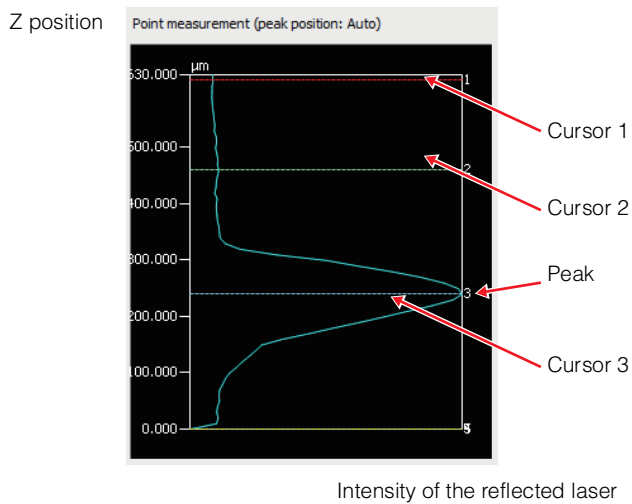


## Z-I Graph of Point Measurement

The Z-I graph of point measurement displays the peak waveform at the measurement point specified in the laser intensity/peak position image display area.

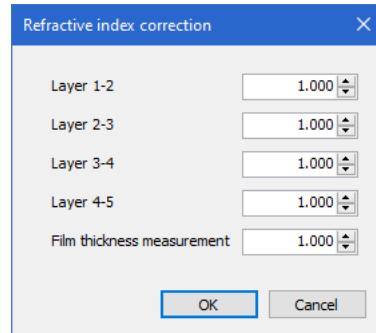
The vertical axis shows the position of the transparent target in the Z direction; and the horizontal axis shows the intensity of the reflected laser. The peak waveform is linked to the graph in the laser intensity/peak position image display area.

You can measure the film thickness between any peaks by moving the cursors (1 to 5) in the graph.



## Screen Used for Correction Coefficient Settings

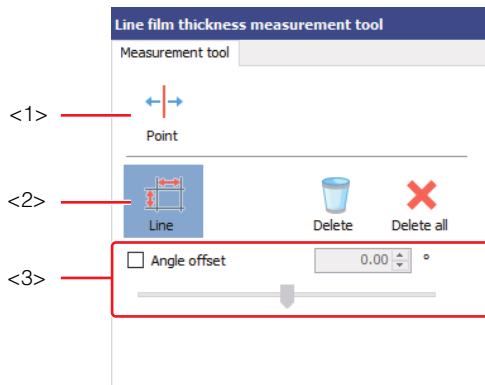
If a transparent target has multiple layers and each layer has a different refractive index, enter the refractive index of each layer to compensate for errors in the measurement values.



Enter the correction coefficients into each of the individual layer boxes and the [Film thickness measurement] box.

## Line Film Thickness Measurement Tool

The line film thickness measurement tool contains buttons to perform measurements and boxes/sliders to configure the cursor angles.



### <1> [Point] button

Clicking this button displays the point measurement line in the laser intensity/peak position image display area. Align the position by dragging.

### <2> [Line] button

Clicking this button displays the film thickness measurement line in the laser intensity/peak position image display area. Align the position by dragging.

### <3> [Angle offset]

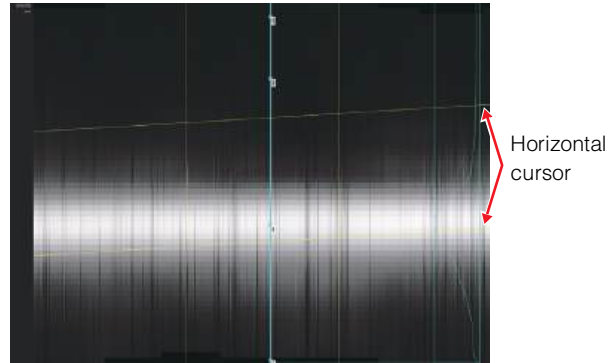
Select the checkbox and enter a value or drag the slider.

### ● Horizontal cursor angle setting

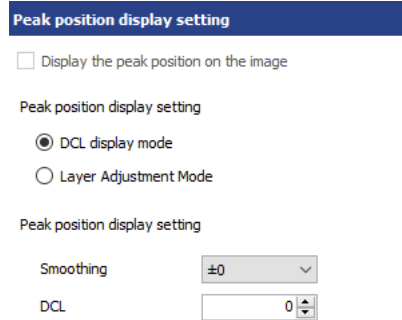
If the entire sample of the transparent target is tilted, the reflective surface of each detected layer will be tilted with respect to the horizontal cursor. You can adjust the angle of the horizontal cursor for such data. To change the cursor angle, select the [Angle offset] checkbox in the parameter setting area and enter a value or drag the slider.



**Reference** The cursor angle can also be adjusted by right-dragging the horizontal cursor.



## Screens Used in Peak Position View Setting (DCL Display Mode)



### [DCL display mode] radio button

Switches to the DCL display mode. You can configure the DLC setting in the DCL display mode.

### [Smoothing] box

Select a smoothing coefficient. The higher the absolute value, the greater the degree of smoothing.

### [DCL] box

Enter the laser intensity level to be cut in numeric value. The laser intensity data below the input value (i.e. dark areas) will be cut.

## Screens Used in Peak Position View Setting (Inter-layer Adjustment Mode)



**The inter-layer adjustment mode can be used with data obtained from VK-X1000/VK-X250/X150/X120 Series and VK-9700/8700 Generation II Series (Viewer Software version 2.0 or later). Earlier versions may produce erroneous results.**

### Peak position display setting

Display the peak position on the image

Peak position display setting

DCL display mode

Layer Adjustment Mode

Peak position display setting

Auto setting

Film Ref. Value   $\mu\text{m}$

Layer Adjustment Filter

Detection sensitivity

Dark cut

Switches to the inter-layer adjustment mode. The peak position display can be set automatically in the inter-layer adjustment mode. You can also manually adjust the base film thickness value and the inter-layer adjustment filters.

### [Auto setting] checkbox

This checkbox should normally be selected unless required otherwise.

When this checkbox is selected, the inter-layer adjustment filter processing and clearing of unneeded peaks are executed automatically.

It may be impossible to accurately measure the film thickness of each layer due to the lack of reflected laser intensity caused by scratches on the film surface and contamination in the film. In such cases, adjust each setting value manually.

Peak position display setting

Auto setting

Film Ref. Value   $\mu\text{m}$

Layer Adjustment Filter

Detection sensitivity

Dark cut

### [Film Ref. value] box

Enter the known value of the film thickness to be measured when the peak waveform of the intermediate layer cannot be detected accurately due to foreign particles in the film. As a result, the laser intensity peaks near the input film thickness value are detected preferentially; and the peak waveforms that occur in between are ignored.

### [Layer Adjustment Filter] box

Set this box when missing data (holes) occur in the laser intensity cross section image as a result of partially missing reflected laser intensity due to foreign particles or scratches. This parameter is used to interpolate the height of an arbitrary pixel with the value of the surrounding pixels (Weak:  $\pm 1$ , Normal:  $\pm 2$ , Strong:  $\pm 4$  pixels) when the pixel is significantly different from the height of the surrounding pixels (i.e. when there is a layer jump).

- [Normal]  
This option is normally selected.
- [Strong]  
Select this to detect unwanted areas below the top surface.
- [Weak], [None]  
Select this to detect unwanted areas when the reflection layer volume is small.

### [Detection sensitivity] box

Sets the sensitivity for detecting the peak position in the range between -50 and 50.

### [Dark cut] box

Sets the threshold for cutting out the dark areas in the range between 0 and 10000. Areas darker than the set value will not be detected as a peak position.

# Laser Film Thickness Measurement (Line Film Thickness Measurement)

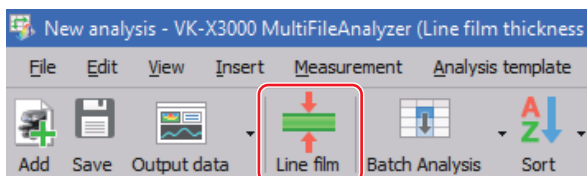
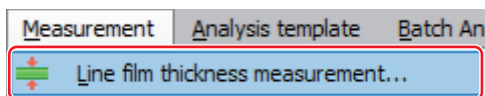
## Displaying the Line Film Thickness Measurement Window

- 1 Open the measurement data or analysis result file.

📖 Opening/Closing File (Page 3-2)

- 2 Select [Line film thickness measurement] from the [Measurement] menu.

Or click the [Line film] button on the toolbar.



The [Line film thickness measurement] window appears.

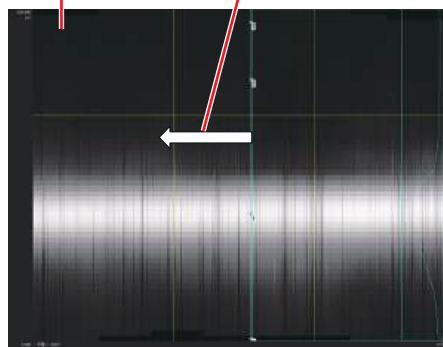
## Setting Measurement Points

- 1 Click the [Point] button in the line film thickness measurement tool to set the measurement point in the laser intensity/peak position image display area.

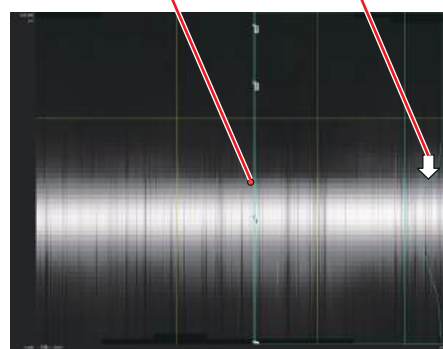
The following is an example of moving the [Point] tool and specifying the measurement point.

When you move the [Point] tool, the Z-I graph of point measurement 1 on the right will move with it. You can specify a measurement point while observing the movement of this graph waveform.

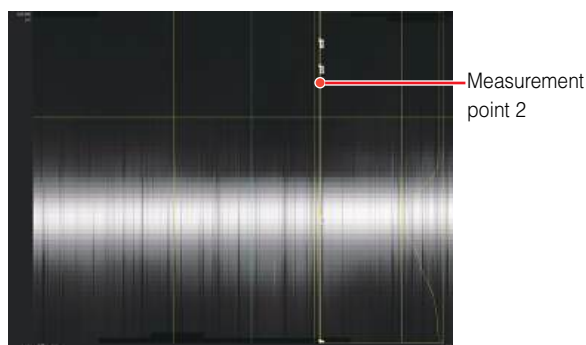
Laser intensity/peak position image display area  
Drag the [Point] tool.



Measurement point 1  
The peak waveform will move with the graph on the left.

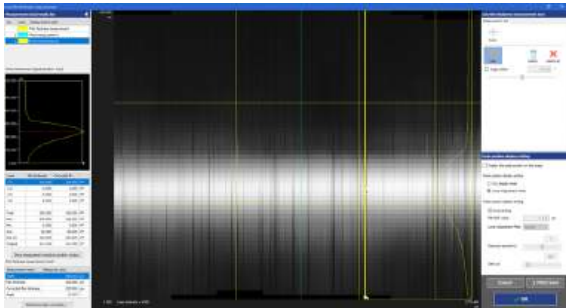


- 2 As in step 1, specify measurement point 2.



## Entering Correction Coefficient

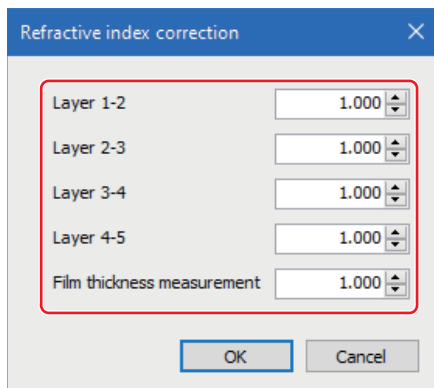
- 1 Click the [Refractive index correction] button.



The [Refractive index correction] dialog box appears.

- 2 Enter the correction coefficients into the [Layer 1-2] to [Layer 4-5] boxes and the [Film thickness measurement] box.

If a transparent target has multiple layers and each layer has a different refractive index, enter the refractive index of each layer. This compensates for errors in the measurement values.

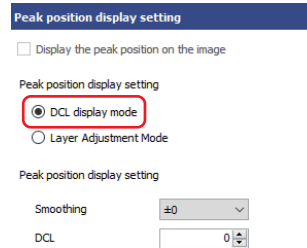


- 3 Click the [OK] button.

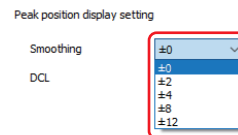
The [Refractive index correction] window is closed, and the setting is applied in the laser intensity cross section profile graph.

## Entering Smoothing and DCL

- 1 Click the [DCL display mode] radio button.

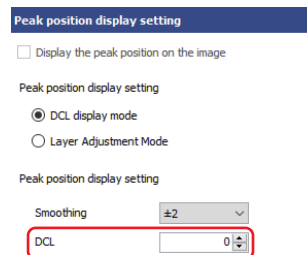


- 2 Select a smoothing coefficient from the list in the [Smoothing] box.



The higher the absolute value, the greater the degree of smoothing.

- 3 Enter the laser intensity level to be cut into the [DCL] box in numeric value.



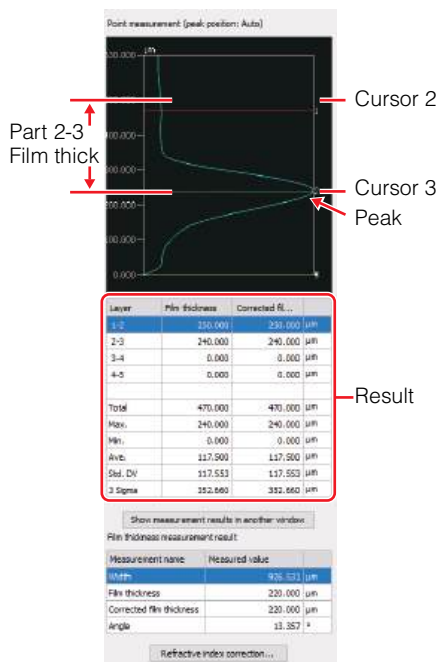
The laser intensity data below the input value (i.e. dark areas) will be cut.

## Measuring Film Thickness

### Measuring Film Thickness with Point Measurement

- 1 Click the point measurement 1.
- 2 Place the cursor in the Z-I graph of point measurement 1 on the peak of the laser intensity data, and measure the film thickness.

The measurement results are displayed in the measurement result display area for point measurement 1.



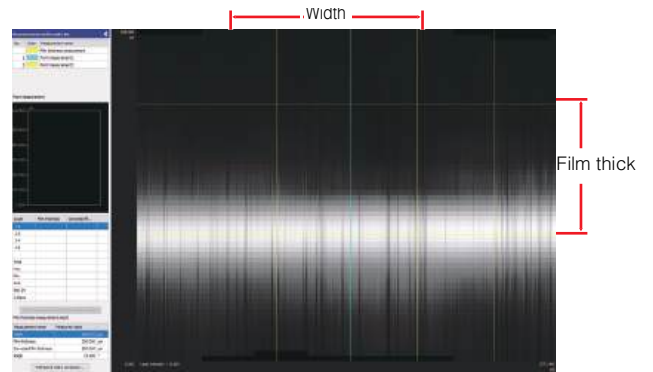
**Reference** The peak is automatically detected and the cursor will be placed on the peak. If necessary, you can adjust the peak by moving the cursor.

- 3 As in steps 1 and 2, also measure the film thickness for point measurement 2.

### Measuring film thickness with horizontal cursors

- 1 Move the horizontal and vertical cursors on the image to measure the film thickness.

When the upper and lower horizontal cursors are placed on the two peaks of the laser intensity profile graph in the laser intensity/peak position image display area, the film thickness between the two layers is displayed in [Film thick] in the measurement results display area. [Correct.film thick] displays the film thickness multiplied by the refractive index of the film ([Correct.coef]).



## Applying the Measurement Result in the Main Screen

### 1 Click the [OK] button in the [Line film thickness measurement] window.

The [Line film thickness measurement] window is closed, and the measurement result is applied in the grid sheet.



By clicking the [Cancel] button, the [Line film thickness measurement] window is closed without applying the setting contents.

## Operating the Grid View Area

Measurement data information and measurement analysis results are displayed on the grid view area. For setting the display contents, see the following.

- Grid view area (Page 2-8)
- Inserting items (Page 2-11)
- Sorting (Page 2-12)

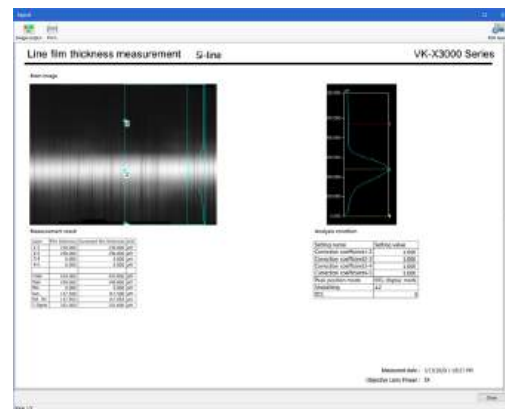
## Exporting Measurement Result

The line film thickness measurement results can be output to a report or Excel file.

### ● Report output

Outputs the results in a defined format in another window.

Refer to Report (Page 3-9).



### ● Exporting to Excel file

Outputs the image data and text to Excel in grid display layout.

Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to Exporting as Excel File (Page 3-15).

### ● Save CSV

Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

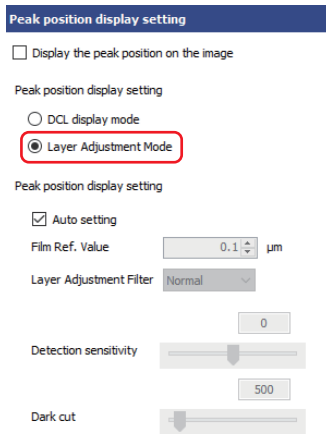
Refer to Exporting measurement result (Page 3-13).

## Setting Peak Position Display in Inter-layer Adjustment Mode

Of the operating procedures for the line film thickness measurement, this section describes "Configuring Peak Position View" in the inter-layer adjustment mode. The rest of the operating procedures is the same as in the DCL display mode.

### Configuring peak position view

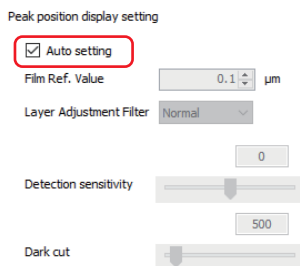
**1** Click the [Layer Adjustment Mode] radio button.



**2** Select the [Auto setting] checkbox.

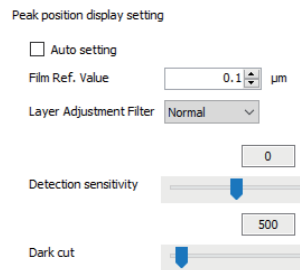
This checkbox should normally be selected unless required otherwise.

When this checkbox is selected, the inter-layer adjustment filter processing and clearing of unneeded peaks are executed automatically.



**3** For manual setting, deselect the [Auto setting] checkbox and adjust the following setting values.

It may be impossible to accurately measure the film thickness of each layer due to the lack of reflected laser intensity caused by scratches on the film surface and contamination in the film. In such cases, adjust each setting value manually.



# Flow of Laser Film Thickness Measurement (Surface Film Thickness Measurement)

The flow of laser film thickness measurement (surface film thickness measurement) is as follows:

## Setup

### Selecting measurement data

- On the grid sheet, select the measurement data on which you want to perform surface film thickness measurement.

📖 Opening/Closing File (Page 3-2)

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Leveling
- Surface shape correction
- Inverting an image
- Smoothing
- Height cut level
- DCL/BCL
- Missing data removal
- Noise removal
- Set invalid area
- Screen rotation
- Image trimming
- C-DIC setting
- Auto Position Alignment

📖 Chapter 5, Measurement Preprocessing (Page 5-1)

## Measurement

### Displaying the surface film thickness measurement window

- Display the surface film thickness measurement window to perform measurement.

📖 Displaying the Surface Film Thickness Measurement Window (Page 13-18)

### Specifying profile line

- Draw a profile line at the measurement position on the image displayed in the surface film thickness measurement window.

When the profile line is drawn on the image, a profile graph and measurement result at the measurement position are displayed.

In addition, set the number of lines to be measured in order to eliminate variations depending on the measurement locations.

📖 Setting Profile Line (Page 13-19)

### Correcting profile graph

- As needed, perform a correction to cut the laser intensity level, correct the tilt, and remove the noise in the profile graph.

📖 Correcting the DCL/BCL (Page 13-20)

📖 Performing Smoothing (Page 13-21)

📖 Correcting the Tilt (Page 13-21)

### Measurement interval setting

- As needed, set measurement intervals on the profile graph to obtain measured values for each interval.

📖 Setting Measurement Intervals (Page 13-22)

### Entering the correction coefficient

Enter the refraction index of each layer of transparent target.

📖 Entering Correction Coefficient (Page 13-22)

## Post-processing

### Exporting measurement result

Output the measurement result to Excel file or create a report.

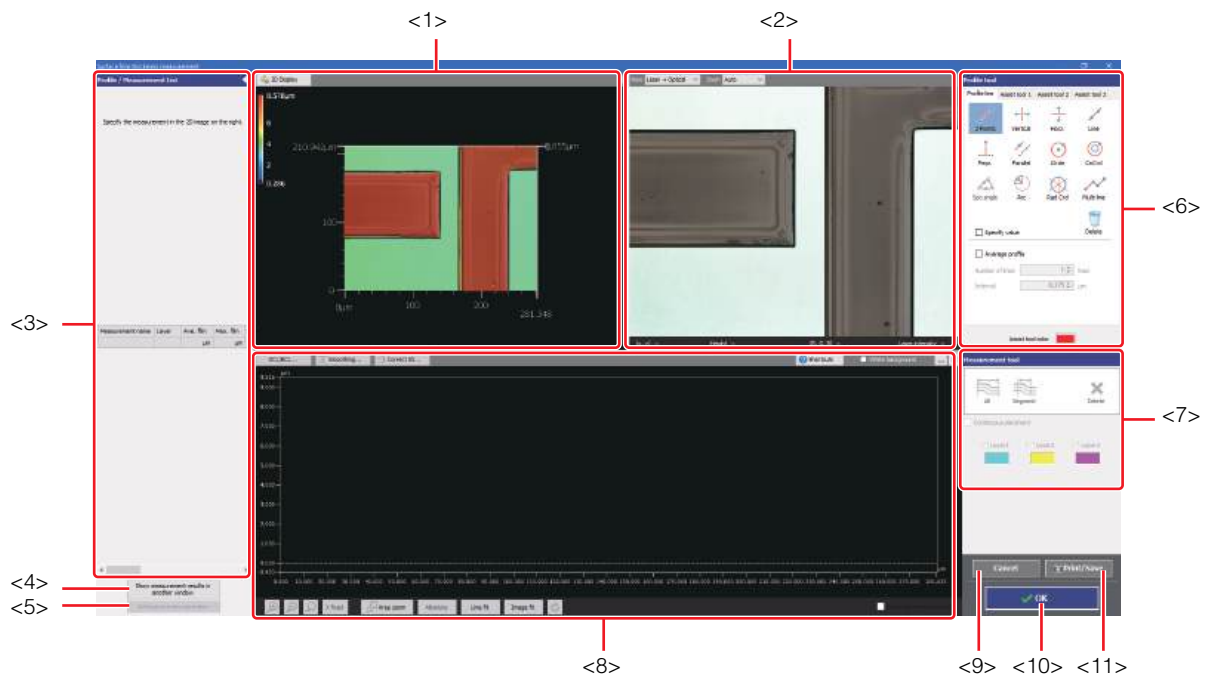
📖 Exporting Measurement Result (Page 13-23)

# Screen Used for Surface Film Thickness Measurement

In surface film thickness measurement, the film thickness shape of a transparent target is measured based on the surface film thickness data (film thickness laser intensity data) measured by the Viewer Software.

The film thickness laser intensity data comprises three layers of laser intensity data consisting of the peak of the reflected laser intensity closest to the measurement unit as the front surface (highest) peak, and the boundary surface of the intermediate layer (middle) and the back surface (lowest), plus the height data of each layer.

By switching the displayed layers, you can check the laser and height images of each layer of the transparent target, as well as measure the thickness and gap of each layer.



## <1> 3D display area

Displays a stereoscopic shape of the sample and the cross section of the selected profile. You can change and operate 3D image display.

📖 Configuring Image Display (Page 4-4)

## <2> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. You can set a profile line on this image. You can also change the display type and magnification of the image.

## <3> Profile/Measurement list

Lists profiles and elements placed on the image, and measurement results.

📖 Profile/Measurement List (Page 13-15)

## <4> [Show measurement results in another window] button

Displays the result displayed on the measured value in a different window. The displayed result can be saved as a text file in CSV format.

## <5> [Refractive index correction] button

If a transparent target has multiple layers and each layer has a different refractive index, enter the refractive index of each layer to compensate for errors in the measurement values.

📖 Chapter 13, Screen Used for Correction Coefficient Settings (Page 13-17)

## <6> Profile tool

Contains buttons to draw various profile lines, such as a straight line and circles.

📖 Profile Tool (Page A-24)

## <7> Measurement tool

Contains buttons used to measure the interval specified by the profile.

## <8> Profile display area

Displays the profile graph for the profile line (or for the selected profile line for the multi-line ) on the image.

📖 Profile Display Area (Page 13-16)

**<9> [Cancel] button**

By clicking, the [Surface film thickness measurement] window is closed without applying the setting contents.

**<10> [OK] button**

By clicking, the [Surface film thickness measurement] window is closed, and the measurement result is applied in the grid sheet

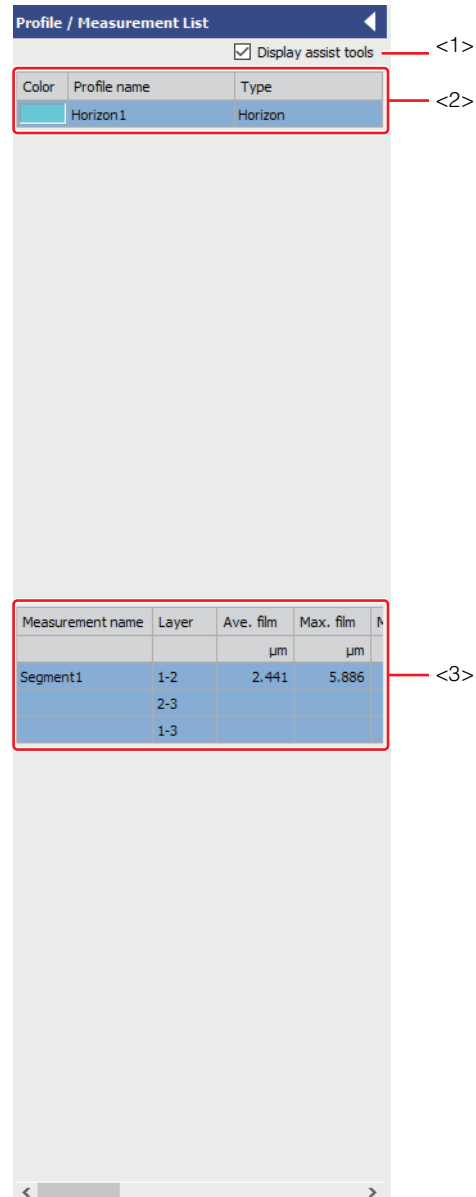
**<11> [Print/Save] button**

Output the screen display contents in the following formats.

- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

**Profile/Measurement List**

The measurement results list displays the list of profiles and elements placed on the image, and the list of measurement results.



**Reference** Click the ◀ button to collapse and hide the profile/measurement results list into the left edge of the window. Click the ▶ button to display it again.

**<1> [Display assist tools] checkbox**

Selecting this checkbox displays the list of the assist tools in the profile list.

**<2> Profile list**

Displays the list of profile lines and assist tools.

The element being selected in the image display area is highlighted in this list.

**<3> Measured value**

Displays the following measured values of the selected profile in the image display area.

Item	Description
Ave. film	Average film thickness over the entire range or within a specified interval
Max. film	Maximum film thickness of the entire range or within a specified interval
Min. film	Minimum film thickness of the entire range or within a specified interval
Std. DV	Variations in data
3 Sigma	Variations in data
Start pt.film thick	Film thickness at the start point
End pt.film thick	Film thickness at the end point
Horizontal distance	[All] is the length of the specified measurement line, and [Part] is the length of a specified interval (from start to end).
Correct.coef	Entered correction coefficient (refractive index)

**Profile Display Area**



**<1> [DCL/BCL] button**

DCL (Dark Cut Level)/BCL (Bright Cut Level) interpolates the height data above the dark cut level (lower threshold) or the bright cut level (upper threshold) with the surrounding data when a portion of the laser intensity of the laser intensity profile graph is judged as abnormal (too low or too high).

**<2> [Smoothing] button**

Applies smoothing filter to the profile.

**<3> [Correct tilt] button**

Performs tilt correction for total profile line.

**<4> [White background] checkbox**

Select this checkbox to make the background color white.

**<5> Profile display area**

Displays the profile graph obtained by using the profile line settings.

**<6> Profile operation controls**

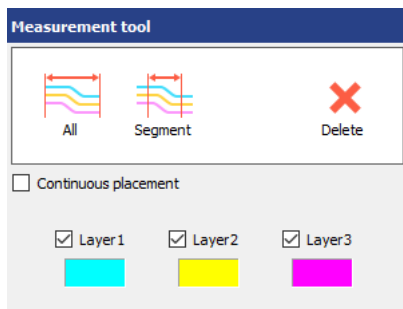
Changes the method to view the profile graph.

Changing the method to view the profile graph (Page 6-33)

## Screen Related to Measurement Interval Type Setting and Display

Sets an arbitrary range on the profile graph to obtain the measurement values for each interval.

You can measure the horizontal distance, film thickness, and film thickness variation of a specific area. Up to 3 locations can be set.



### [All]

Sets all intervals as the measurement range.

### [Segment]

Sets the interval between two clicked points as the measurement range.

### [Continuous placement] checkbox

When this checkbox is selected, the tool selection state is maintained, the element can be placed repeatedly.

### [Layer 1] to [Layer 3] check box

Click the check box to show or hide the measurement line.

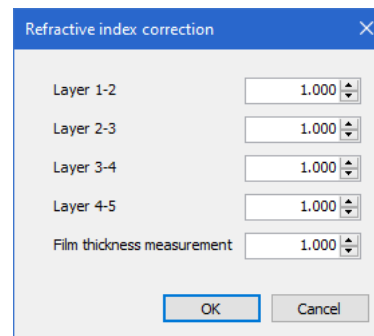
### [Layer 1] to [Layer 3] color palettes

You can change the color of the measurement lines in the [Layer 1] to [Layer 3] color palettes.

Click the color palette to display the [Color] dialog box, and select a new color.

## Screen Used for Correction Coefficient Settings

If a transparent target has multiple layers and each layer has a different refractive index, enter the refractive index of each layer to compensate for errors in the measurement values.



Enter the correction coefficients into each of the individual layer boxes and the [Film thickness measurement] box.

# Laser Film Thickness Measurement (Surface Film Thickness Measurement)

## Displaying the Surface Film Thickness Measurement Window

### 1 Open the measurement data or analysis result file.

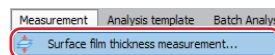
Opening/Closing File (Page 3-2)



Perform the following preprocessing as needed.

- Reference Plane Settings
  - Reference Plane Settings (Page 5-3)
- Leveling
  - Leveling (Page 5-9)
- Surface shape correction
  - Surface Shape Correction (Page 5-11)
- Inverting an Image
  - Inverting an Image (Page 5-16)
- Smoothing
  - Smoothing (Page 5-17)
- Height cut level
  - Height Cut Level (Page 5-19)
- DCL/BCL
  - DCL/BCL (Page 5-22)
- Missing data removal
  - Missing Data Removal (Page 5-25)
- Noise removal
  - Noise Removal (Page 5-26)
- Set invalid area
  - Set invalid area (Page 5-28)
- Screen rotation
  - Screen rotation (Page 5-29)
- Image trimming
  - Image trimming (Page 5-30)
- Auto Position Adjustment
  - Auto Position Alignment (Page 5-34)
- C-DIC setting
  - C-DIC setting (Page 5-32)

### 2 Select [Surface film thickness measurement] from the [Measurement] menu. Or click the [Surf. F. T.] button on the toolbar.



The [Surface film thickness measurement] window appears.

## Setting Profile Line

Set a profile line at the measurement position on the image displayed in the surface film thickness measurement window. When the profile line is specified on the image, a profile graph at the measurement position is displayed.

- 1 Select the **[Assist tool 1] tab, [Assist tool 2], or [Assist tool 3] tab in the profile tool, and click the desired button to place an element on the image as needed.**

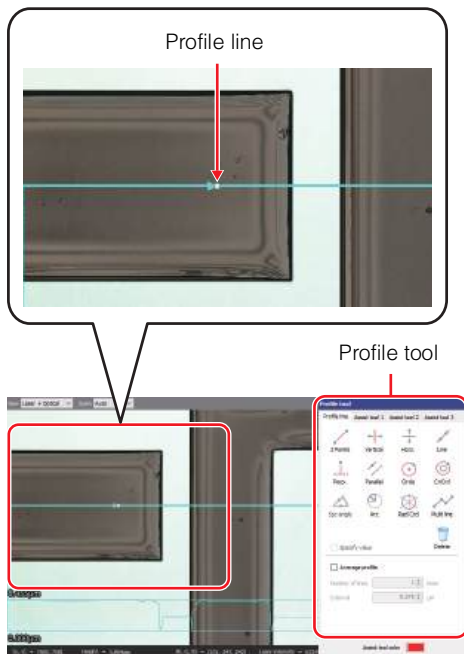
A profile line consists of elements such as points and lines. If you place these elements on the measurement position in advance using the buttons on the [Assist tool 1] tab, [Assist tool 2] tab, or [Assist tool 3] tab, you can draw a profile line accurately and efficiently in a way that is similar to actual drawing.

📖 What is an Element? (Page A-22)

📖 How to use assist tools (Page 6-25)

- 2 Click the desired button on the **[Profile line] tab in the profile tool and draw a profile line on the image.**

📖 How to use profile line tool (Page A-26)



When a profile line is drawn on the image, an actual cross section profile graph is displayed in the profile display area. Because the profile graph is updated in real time during the drawing process of the profile line, you can draw the profile line while confirming the waveform.

Additionally, the Profile/Measurement List displays the profile list.

## Setting Multiple Measurement Lines

- 1 Check the **[Average profile] checkbox in the profile tool.**
- 2 In the **[Number of lines] and [Interval] boxes of the profile tool, enter the number of measurement lines and the interval respectively.**

Specifying the number of lines to be measured allows variations in measurement areas to be eliminated and statistical results based on multiple pieces of measurement data to be obtained.

### [Number of lines] box

In addition to the specified measurement line (reference line), enter the number of lines (n) to be drawn on both sides of the line. When the reference measurement line is drawn, measurement lines of specified number (n) are automatically drawn on both sides of the reference line, and the total number of measurement lines will be  $2n + 1$ .

### [Interval] box

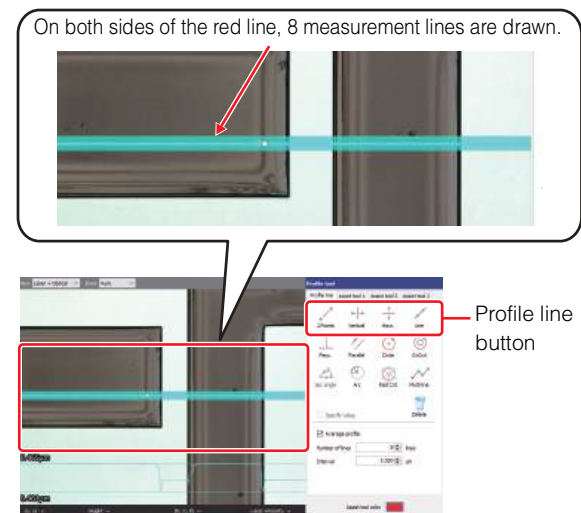
Enter the interval between measurement lines as the number of lines (m). The greater the value, the larger the interval.

📌 Point The average profile setting function is unavailable for [Circle], [CnCrd], [Rad Crd], and [Multi line].

- 3 Click the desired button and draw a profile line on the image.

📖 Types of Measurement Lines and How to Draw (Page A-22)

Example: When horizontal lines are drawn with [Number of lines]: 8 lines and [Interval]:  $0.500 \mu\text{m}$



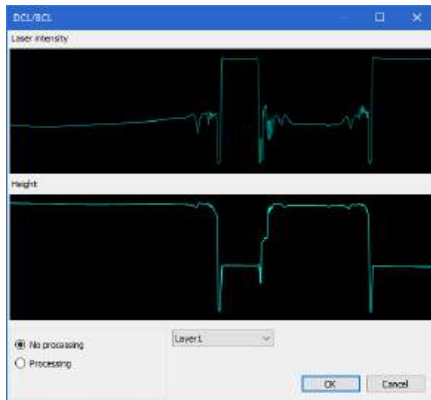
When a profile line is drawn on the image, a profile graph is displayed in the profile graph display area. Also, the average of the measurement results for all the measurement lines is displayed in the measurement result display area.

## Correcting the DCL/BCL

DCL (Dark Cut Level)/BCL (Bright Cut Level) cuts the laser intensity level above the dark cut level (lower threshold) or the bright cut level (upper threshold) with the surrounding data when a portion of the laser intensity of the laser intensity profile graph is judged as abnormal (too low or too high).

- 1 Click the [DCL/BCL] button in the profile display area.

The [DCL/BCL] window appears.



- 2 Click the [Processing] radio button.

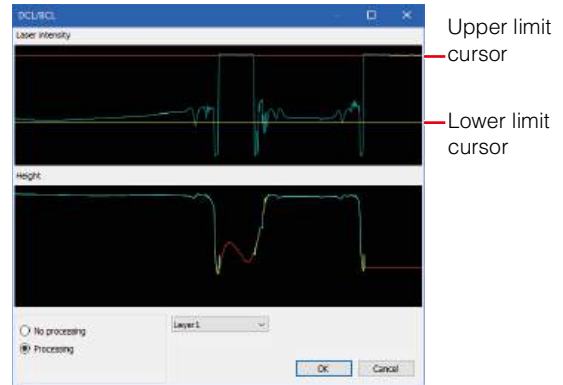
### [No processing] radio button

The changes in DCL/BCL are not reflected in the display.

### [Processing] radio button

Smooths height data (cross section Profile) by smoothing and cutting level processing.

- 3 Drag the upper limit and lower limit cursors to set the threshold.



The height profile graph after correction is displayed in the [DCL/BCL] window.

### Upper limit cursor

The laser intensity data higher than the cursor will be cut (bright areas).

### Lower limit cursor

The laser intensity data lower than the cursor will be cut (dark areas).

- 4 Click the [OK] button in the [DCL/BCL] window.

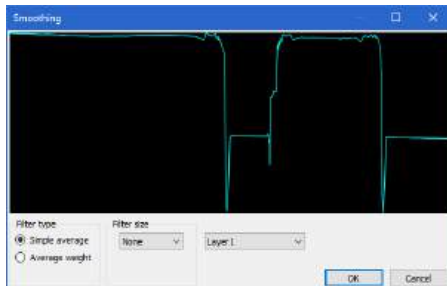
This executes the correction.

## Performing Smoothing

The smoothing operation makes a waveform of graph smoother by averaging measured data. Perform this where required.

### 1 Click the [Smoothing] button in the profile display area.

The [Smoothing] window appears.



### 2 Select a filter type.

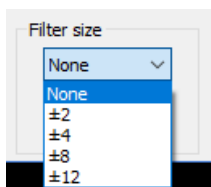
#### [Simple average] radio button

Simply averages the height data in the intervals specified in [Filter size]. This averaging method greatly reduces noise, but profiles, such as edges, become softer as well.

#### [Average weight] radio button

Multiplies height data in the intervals specified in [Filter size] by a weighting factor, and then performs calculation. This averaging method makes shapes smoother, preserving the sharpness of edges as much as possible.

### 3 Select a filter size.



### 4 Click the [OK] button in the [Smoothing] window.

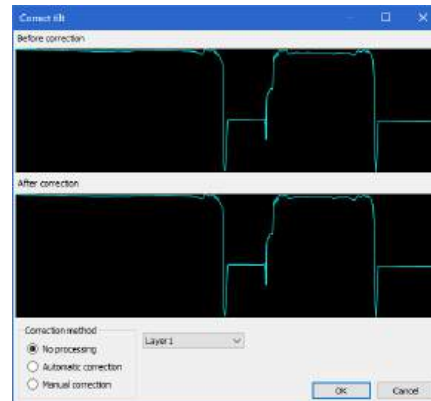
This executes the correction.

## Correcting the Tilt

Corrects for the tilt of the profile along a specified line. Perform this where required.

### 1 Click the [Correct tilt] button.

The [Correct tilt] window appears.



#### Before correction

The profile graph before correction appears.

#### After correction

The profile graph after correction appears.

### 2 Select the correction method.

When selecting the correction method, the straight line to show the tilt of the profile is displayed.

#### [No processing] radio button

Restores the tilt correction once set back to the original state.

#### [Automatic correction] radio button

Automatically corrects to make the area surrounded by the vertical cursors horizontal on the profile graph of [Before correction].

#### [Manual correction] radio button

The yellow markers are displayed on the graph before correction. Drag these two point markers to adjust the tilt.

### 3 Click the [OK] button in the [Correct tilt] window.

The tilt correction is executed.

## Setting Measurement Intervals

Set measurement intervals on the profile displayed on the profile display area, and obtain measurement values for each interval.

You can measure the average, maximum, and minimum film thicknesses of the set measurement interval.

### ■ Selecting all parts

#### 1 Click the [All] button.

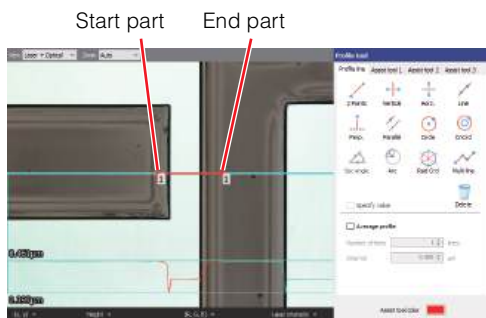
The measurement range will be set.

### ■ Selecting specific parts

#### 1 Click the [Segment] button.

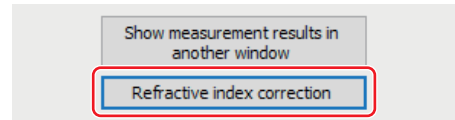
#### 2 Set a range in the profile display area.

The measurement range will be set.



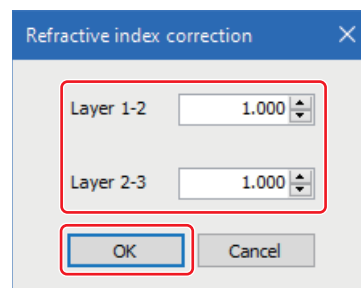
## Entering Correction Coefficient

#### 1 Click the [Refractive index correction] button at the bottom left of the screen



The [Refractive index correction] dialog box appears.

#### 2 After entering the correction coefficient, click the [OK] button.



## Applying the Measurement Result in the Main Screen

#### 1 Click the [OK] button in the [Surface film thick. meas] window.

The [Surface film thickness measurement] window is closed, and the measurement result is applied in the grid sheet.

**Reference** By clicking the [Cancel] button, the [Surface film thickness measurement] window is closed without applying the setting contents.

## Operating the Grid View Area

Measurement data information and measurement analysis results are displayed on the grid view area. For setting the display contents, see the following.

📖 Grid view area (Page 2-8)

📖 Inserting items (Page 2-11)

📖 Sorting (Page 2-12)

## Exporting Measurement Result

Profile measurement results can be output to a report or an Excel file.

### ● Report output

Outputs the results in a defined format in another window.


Refer to  Report (Page 3-9).



### ● Exporting to Excel file

Outputs the image data and text to Excel in grid display layout.


Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to  Exporting as Excel File (Page 3-15).

### ● Save CSV

Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

Refer to  Exporting measurement result (Page 3-13).

### ■ Measurement results display

Displays the following measured values for each part.

Layer	: Measurement target layer
Av.film thick	: Average film thickness of the entire range or within a specified interval
Max.	: Maximum film thickness of the entire range or within a specified interval
Min.	: Minimum film thickness of the entire range or within a specified interval
Standard deviation	: Variations in data
3 Sigma	: Variations in data
Start pt.film thick	: Film thickness at the start point
End pt.film thick	: Film thickness at the end point
Horizontal distance	: [All] is the length of the specified measurement line, and [Part] is the length of a specified interval (from start to end).
Correct.coef	: Entered correction coefficient (refractive index)

# Flow of Spectral Film Thickness Measurement

The flow of spectral film thickness measurement is as follows:

## Setup

### Selecting measurement data



On the grid sheet, select the measurement data on which you want to perform spectral film thickness measurement.

📖 Opening/Closing File (Page 3-2)



## Measurement

### Displaying the spectral film thickness measurement window



Display the spectral film thickness measurement window to perform measurement analysis.

📖 Displaying the Spectral Film Thickness Measurement Window (Page 13-29)

### Layer configuration setting



Sets the layer configuration of the sample.

📖 Setting Layer Configuration (Page 13-29)



## Post-processing

### Exporting measurement result

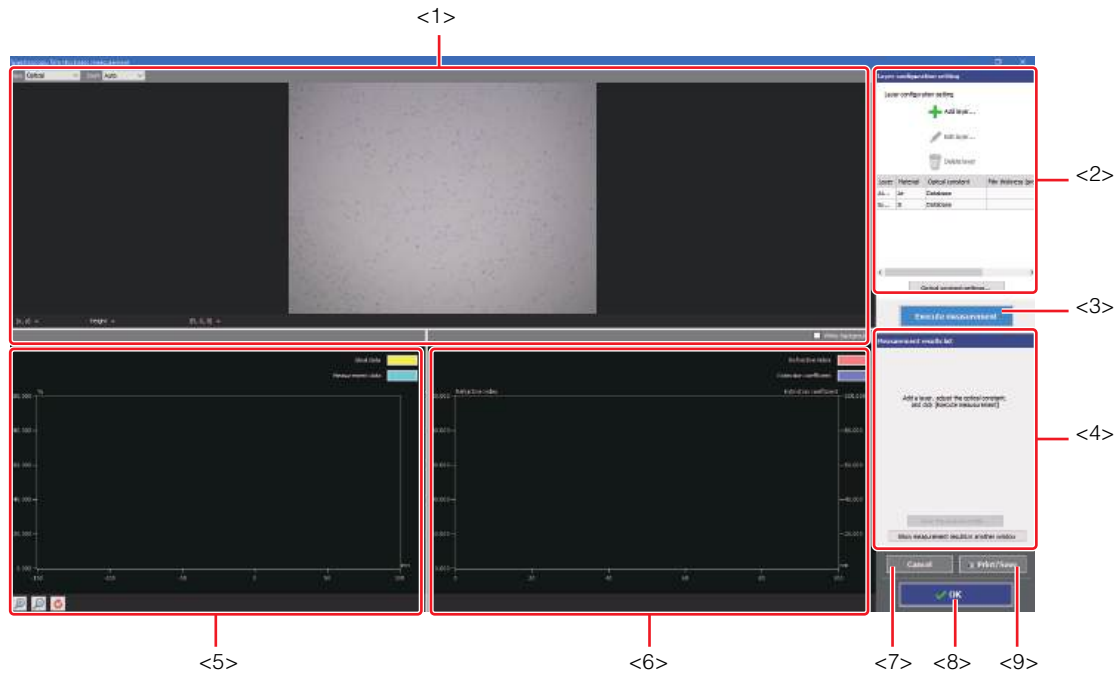
Output the measurement result to Excel file or create a report.

📖 Exporting Measurement Result (Page 13-31)

# Screen Used for Spectral Film Thickness Measurement

In spectral film thickness measurement, the film thickness of a transparent target is measured based on the spectral interference data on a measurement line specified in the Viewer Software.

Spectral film thickness data is obtained by using white light interference and breaking down the signal into each wavelength. You can obtain a graph showing the wavelength (horizontal axis) against reflectance (vertical axis); and you can also determine the film thickness based on the refractive index of the film or the conditions under which the refractive index can be calculated.



## <1> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. You can also change the display type and magnification of the image.

Reference: Changing the display type and the magnification of the image can be done using the [View] box and the [Zoom] box respectively displayed on the upper part of image display area.

## <2> Layer configuration setting tool

Allows you to add, edit, and delete layers, as well as configure the optical constants in detail.

📖 Layer Configuration Setting Tool (Page 13-26)

📖 Screen Used for Optical Constants Detail Setting (Page 13-28)

## <3> [Execute measurement] button

Click to perform measurements according to the layer configuration settings.

## <4> Measurement results list

Lists the measurement results obtained from the measurement area specified on the image.

📖 Measurement results list (Page 13-26)

## <5> [Reflectn] display area

Displays the reflectance graph.

📖 [Reflectn] Display Area (Page 13-27)

## <6> [Refract.idx, Extinct.coef] display area

Displays the refraction index/extinction coefficient graph.

📖 [Refract.idx, Extinct.coef] Display Area (Page 13-27)

## <7> [Cancel] button

By clicking, the [Spectroscopy film thickness measurement] window is closed without applying the setting contents.

## <8> [OK] button

By clicking, the [Spectroscopy film thickness measurement] window is closed, and the measurement result is applied in the grid sheet

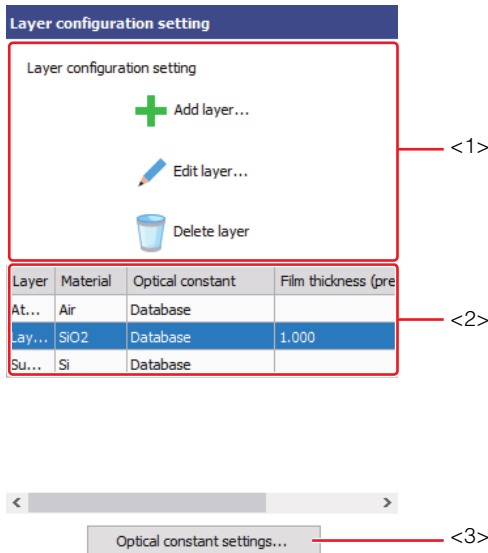
## <9> [Print/Save] button

Output the screen display contents in the following formats.

- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

## Layer Configuration Setting Tool

The layer configuration setting tool allows you to add, edit, and delete layers, as well as configure the optical constants in detail.



### <1> Layer configuration setting

#### [Add layer] button

When this button is clicked, the [Add layer] dialog box appears.

Set the material and film thickness (predicted value) and click the [OK] button to add a layer to the layer configuration.

#### [Edit layer...] button

When this button is clicked, the [Add layer] dialog box appears.

Editing the material and film thickness (predicted value) in the [Add layer] dialog box updates the layers in the layer configuration.

#### [Delete layer] button

Deletes the selected layer.

### <2> Layer configuration

Displays the layer configuration.

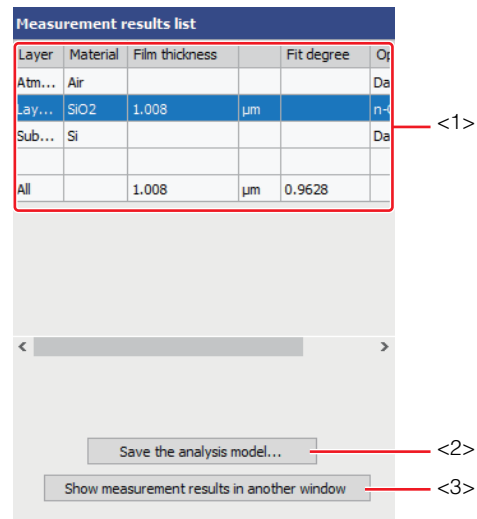
### <3> [Optical constant settings...] button

Clicking this button displays the [Optical constant settings] dialog box.

Set the calculation method and click the [OK] button to update the optical constants of the layer configuration.

## Measurement results list

The measurement results list displays a list of measurement results obtained from the layer configuration setting.



### <1> Measurement results list

The layer materials, film thickness, list of optical constants, and the overall film thickness and fit degree are displayed.

Also, the following items and the measured value list are also displayed for all layers.

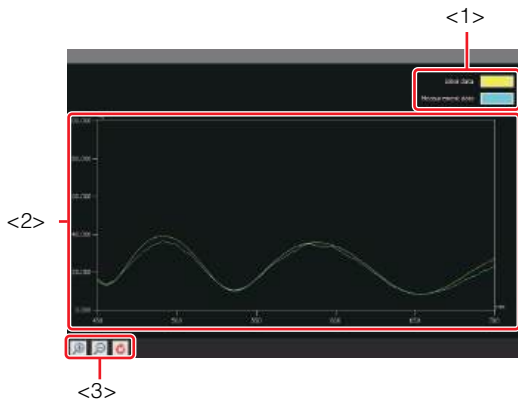
### <2> [Save the analysis model] button

The analysis model set in the [Optical constant settings] dialog box can be saved. The file extension is analysis model format (\*.sft).

### <3> [Show measurement results in another window] button

Displays the result displayed on the measured value in a different window. The displayed result can be saved as a text file in CSV format.

## [Reflectn] Display Area



### <1> [Color settings]

Select display colors for [Ideal data], and [Measurement data] from the color palette.

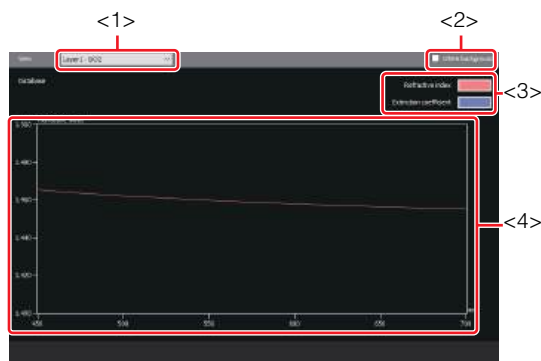
### <2> [Reflectn] display area

Displays the reflectance graph.

### <3> Reflectance operation controls

Changes the display size of the reflectance curve.

## [Refract.idx, Extinct.coef] Display Area



### <1> [View] box

Select a layer.

### <2> [White background] checkbox

Select this checkbox to make the background color white.

### <3> [Color settings]

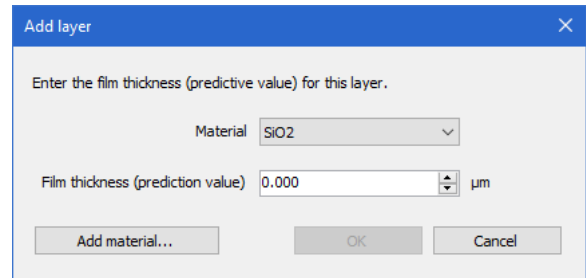
Select display colors for [Refractive index], and [Extinction coefficient] from the color palette.

### <4> [Refract.idx, Extinct.coef] display area

Displays the refraction index/extinction coefficient graph.

## Screen Used for Adding Layers

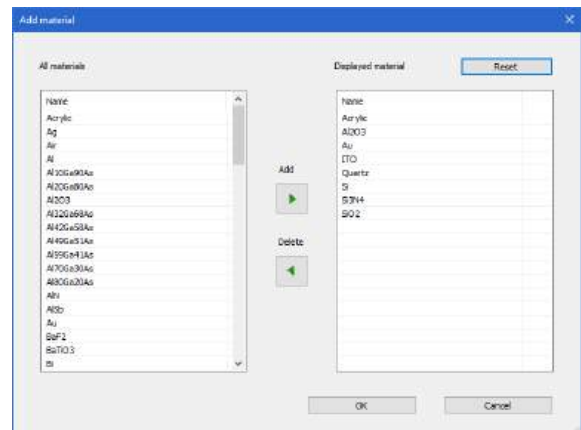
In spectral film thickness measurement, enter the material and film thickness (predicted value) to calculate the reflectance from the refractive index and thickness of the film and compare the theoretical value with the measured waveform.



Enter the material in the [Material] box and the predicted film thickness in the [Film thickness (prediction value)] box.

## Screen used for adding materials

The frequently used materials are displayed in the [Material] box.



### All materials

The list of all materials.



Point

Click while pressing Ctrl or Shift to select multiple data.

### Displayed material

The materials displayed in the [Material] box in the [Add layer] dialog box.

### [Reset] button

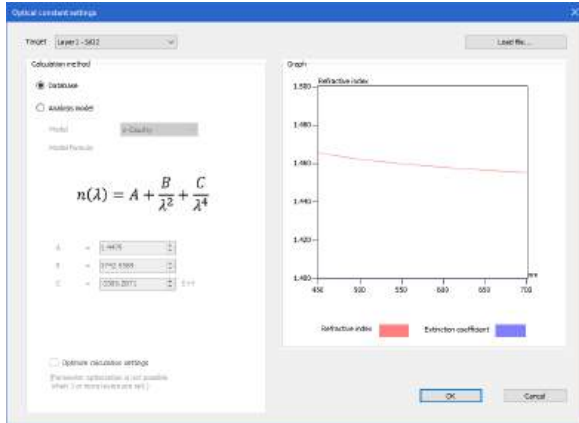
Resets the displayed material setting.

### [Add]/[Delete] button

Adds or deletes the selected material.

## Screen Used for Optical Constants Detail Setting

Sets the calculation method for optical constants such as the refractive index and extinction coefficient of a material.



### <1> [Target] box

Select the layer for which you wish to change the calculation method for optical constants.

### <2> [Load file...] button

Imports an analysis model file (\*.sft).

### <3> Calculation method

#### [Database] radio button

Select to use the refractive index and extinction coefficient of each material registered in this software.

#### [Analysis model] radio button

Select a model from the [Model] box and adjust each coefficient.

When the [Optimize calculation settings] checkbox is selected, the parameters of the analysis model will be adjusted during the film thickness calculation.

### <4> Graph

The refractive index and extinction coefficient graphs are updated according to the optical constants you have set.

# Spectral Film Thickness Measurement

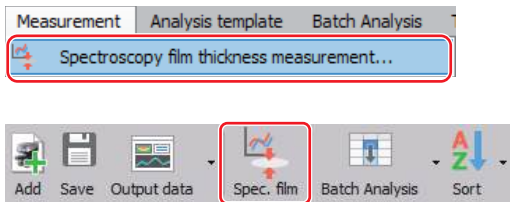
## Displaying the Spectral Film Thickness Measurement Window

Display the spectral film thickness measurement window to perform measurement.

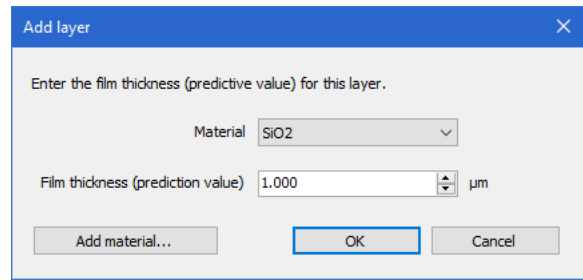
**1** Open the measurement data or analysis result file.

📖 Opening/Closing File (Page 3-2)

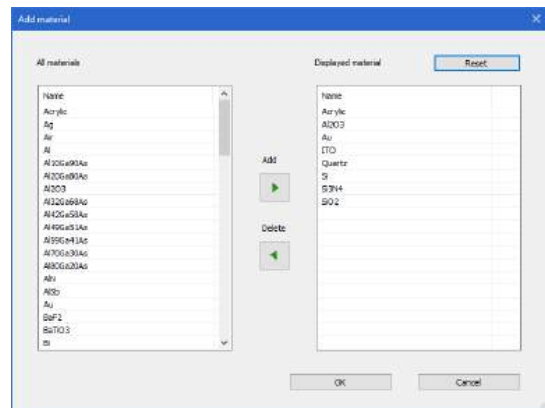
**2** Select [Spectroscopy film thickness measurement] from the [Measurement] menu. Or click the [Spec. film] button on the toolbar.



The spectral film thickness measurement window appears.



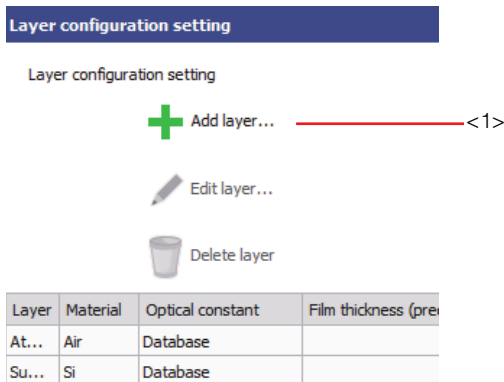
If the no applicable material is available in the material selection in the [Add layer] window, click the [Add material] button to retrieve materials from the database.



## Setting Layer Configuration

Sets the layer configuration of the sample.

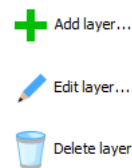
**1** Under [Layer configuration setting], click the [Add layer] button and enter the layer configuration (predicted material and film thickness values) of the measured sample.



If the sample consists of more than one layer, enter additional configuration for the second and subsequent layers.

### Layer configuration setting

Layer configuration setting

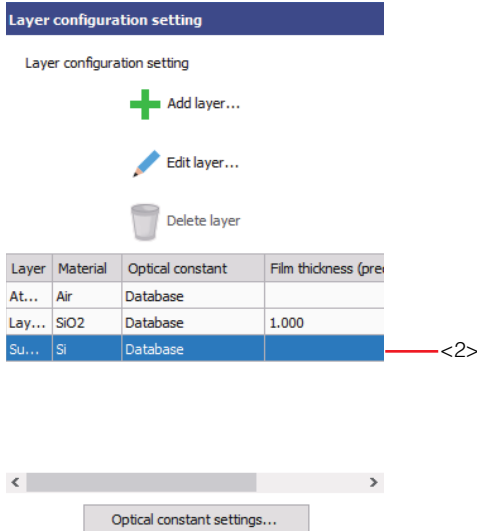


Layer	Material	Optical constant	Film thickness (pre)
At...	Air	Database	
Lay...	SiO2	Database	1.000
Su...	Si	Database	

It will be added on top of the currently selected layer.

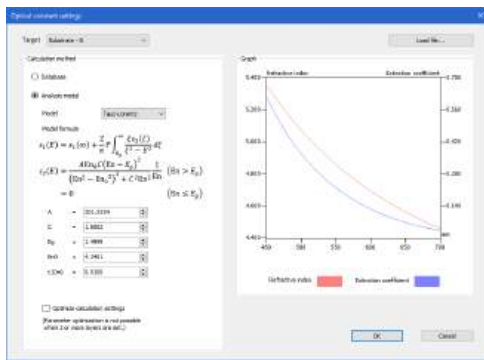
Layer	Material	Optical constant	Film thickness (pre)
At...	Air	Database	
Lay...	Si	Database	0.100
Lay...	SiO2	Database	1.000
Su...	Si	Database	

**2** If necessary, double-click the Substrate field and change the material and other settings.



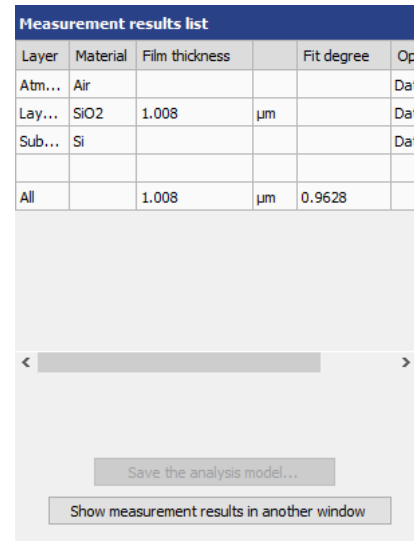
**Important**

If the layer configuration of the sample is unknown, perform the measurement without entering the layer configuration (i.e. predicted material and film thickness values). Optionally, click the [Optical constant settings] button to select a [Analysis model] for calculating each layer.



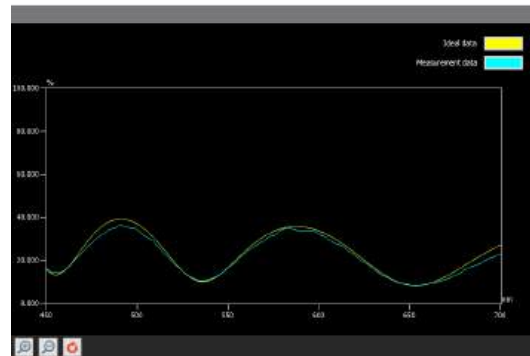
**3** Click the [Execute measurement] button.

The measurement results for each film thickness are displayed in the measurement results list.



**[Reflectn]**

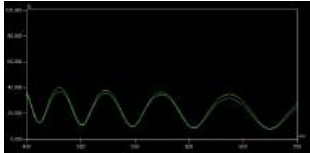
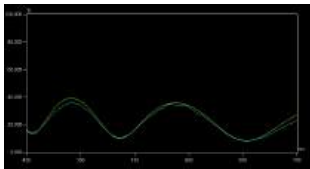
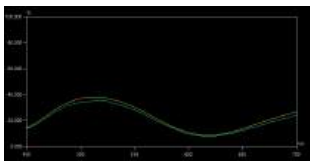
This graph shows the level of reflection intensity for each wavelength.



When the sample materials are the same, the reflection intensity and the number of peaks vary with the film thickness.

Reference

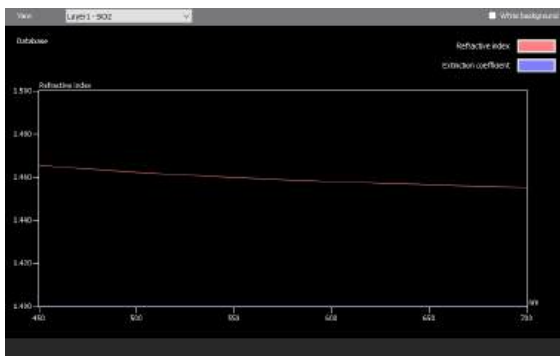
In spectral film thickness measurement, the difference in film thickness is measured based on the increase in the wave count with respect to the spectral wavelength as the film thickness increases.

SiO<sub>2</sub> 2000nmSiO<sub>2</sub> 1000nmSiO<sub>2</sub> 500nm

### [Refract.idx / Extinct.coef]

This graph shows the refractive index and extinction coefficient for each wavelength.

The spectral interference is calculated based on this graph.



Reference

The extinction coefficient will be "0" depending on the material.

## Applying the Measurement Result in the Main Screen

### 1 Click the [OK] button in the [Spectroscopy film thickness measurement] window.

The [Spectroscopy film thickness measurement] window is closed, and the measurement result is applied in the grid sheet.

Reference

By clicking the [Cancel] button, the [Spectroscopy film thickness measurement] window is closed without applying the setting contents.

## Operating the Grid View Area

Measurement data information and measurement analysis results are displayed on the grid view area. For setting the display contents, see the following.

Grid view area (Page 2-8)

Inserting items (Page 2-11)

Sorting (Page 2-12)

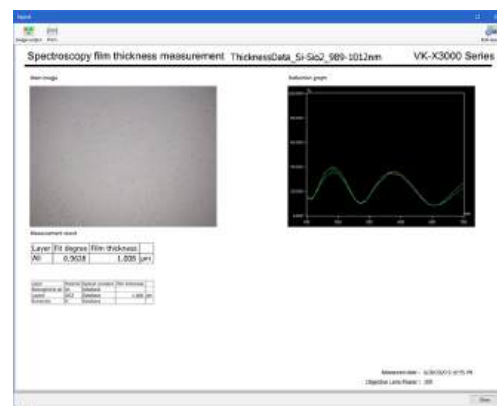
## Exporting Measurement Result

The spectral film thickness measurement results can be output to a report or Excel file.

### ● Report output

Outputs the results in a defined format in another window.


Refer to Report (Page 3-9).



● **Exporting to Excel file**

Outputs the image data and text to Excel in grid display layout.


Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to  Exporting as Excel File (Page 3-15).

● **Save CSV**

Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

Refer to  Exporting measurement result (Page 3-13).

# Chapter 14

## Parameter Recommendation

This section describes the function to support the selection of the parameter appropriate for comparing the difference of two measurement data.

Flow of Parameter Recommendation .....	Page 14-2
Screen Used for Parameter Recommendation ..	Page 14-3
Parameter Recommendation .....	Page 14-7

# Flow of Parameter Recommendation

Support the selection of the parameter with difference by comparing the two groups of the roughness parameters of the measurement data.

## Setup

### Selecting measurement data

- ▼ Open multiple data for which the parameter recommendation is performed.  
📖 Opening/Closing File (Page 3-2)

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Leveling
- Surface shape correction
- Inverting an image
- Smoothing
- Height cut level
- DCL/BCL
- Missing data removal
- Noise removal
- Set invalid area
- Screen rotation
- Image trimming
- C-DIC setting
- Auto Position Adjustment

📖 Chapter 5, Measurement Preprocessing (Page 5-1)

## Comparison

### Adjust parameter settings

- ▼ Display the [Detail settings] dialog box, and adjust the parameter settings.  
📖 Setting Parameters (Page 14-8)

### Executing the parameter recommendation

- ▼ Display the [Parameter recommendation] dialog box, and divide the measurement data into two.  
📖 Using the Recommendation Function (Page 14-7)

### Selecting parameters

Select parameters based on the execution result. The result is reflected in the grid sheet.

📖 Using the Recommendation Function (Page 14-7)

## Post-processing

### Exporting measurement result

Output the measurement result to Excel file or create a report.

📖 Exporting Analysis Result (Page 15-28)

# Screen Used for Parameter Recommendation

Quantitatively compares 2 sample groups using multiple parameters and displays the degree of difference.

Select [Parameter Recommendation] from the [Tools] menu to display the [Parameter Recommendation] dialog box.

The following describes the name and function of parts of the [Parameter Recommendation] dialog box.



## <1> Arrow button

Clicking this button distributes measurement data to be compared in group 1 or group 2.

## <2> [Group Name] box

You can enter a group name. By default, [Group 1] and [Group 2] are displayed.

## <3> [Image list] button

Clicking this button displays the group measurement data in the image list display window.

## <4> [Settings] button

Clicking this button displays the [Detail settings] dialog box. Set [Parameter].

Detail settings (Page 14-5)

## <5> [Split surface data into four areas] checkbox

Selecting this checkbox creates 4 data from 1 measurement data, and analyzes the data.

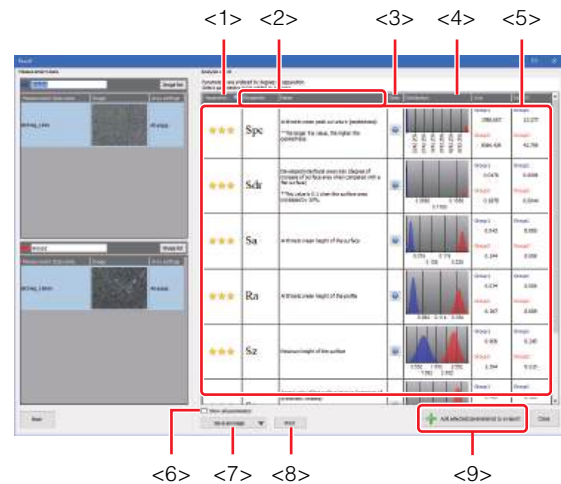
## Point

A message to encourage data input may be displayed in the following case:

- When the [Split surface data into four areas] checkbox is not selected.

At least 4 measurement data are required to execute the parameter recommendation. Selecting the [Split measurement data into four areas] checkbox creates 4 data from 1 measurement data, and analyzes the data.

## Result view



## <1> [Separation]

Shows the degree of separation of values between 2 groups. If the degree of separation of a parameter is large, the quantitative difference is large.

Degree of separation = (Average value for Group 1 - Average value for Group 2) / (Standard deviation of Group 1 + Standard deviation of Group 2)

★★★★ ...Degree of separation is 2 or more

★★★☆☆ ...Degree of separation is 1 or more

★★☆☆☆ ...Degree of separation is 0.5 or more

★☆☆☆☆ ...Degree of separation is less than 0.5

## <2> [Parameter], [Name]

Display the parameter abbreviation and name.

## <3> [Desc]

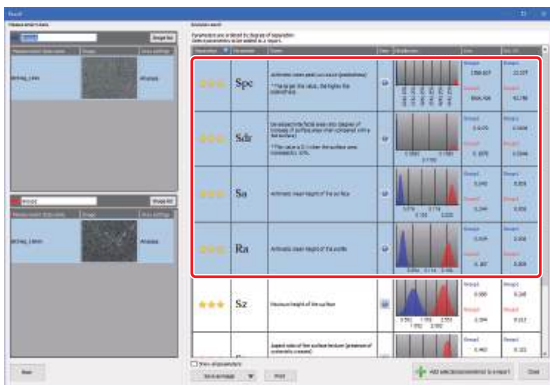
Click the [?] button to display the description of the parameter.

**<4> [Distribution]**

Calculate the average and standard deviation from the parameter analysis result, and display the graph applied to the normal distribution.

**<5> Parameter**

- Each time you click, the selection is switched.
- Multiple parameters can be selected.



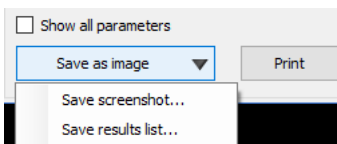
**<6> [Show all parameters] checkbox**

Selecting this box displays the analysis results.

- Reference**
- By default, seven parameters are displayed. For setting parameters, refer to Detail settings (Page 14-5).
  - The line roughness profile line and the surface roughness area are automatically set.

**<7> [Save as image] button**

Save the [Results] dialog box as image (PNG, JPEG, or TIFF).



**[Save screenshot...]**

Save the [result] dialog box as image.

**[Save result list...]**

Save all analysis results displayed in the [Analysis result] dialog box as images.

The [Save as image] dialog box appears. Select the file format from among PNG file format (\*.png), JPEG file format (\*.jpg, \*.jpeg) or TIFF file format (\*.tif, \*.tiff).

**<8> [Print] button**

Print all analysis results displayed in the [Analysis result] dialog box.

**Reference** The following operations are provided from the right-click menu of the parameter line.



**[Save result list...]**

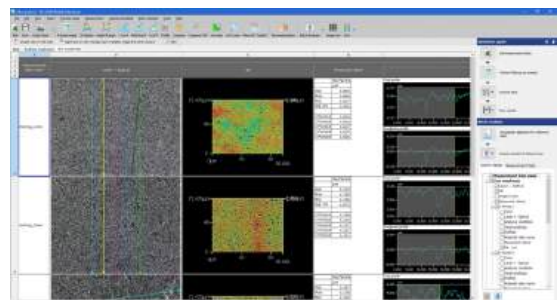
Save analysis results as images.

**[Output CSV file]**

Output the parameter value as a CSV file.

**<9> [Add selected parameter(s) to a report] button**

According to the parameters, grid sheets of [Line roughness] and [Surface roughness] are added, and the results are displayed.

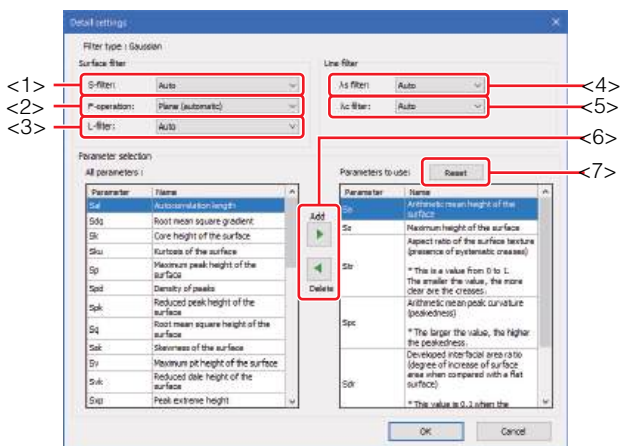


## Detail settings

Click the [Settings] button in the [Parameter Recommendation] dialog box to display the [Detail settings] dialog box.

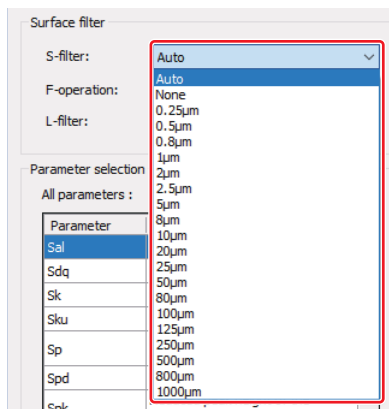
The following describes the name and functions of each part of the [Detail settings] dialog box.

For details of each parameter, refer to [Roughness Definitions \(Page 10-14\)](#), [Surface Roughness Definitions \(Page 12-14\)](#).



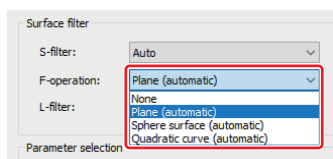
### <1> [S-filter] box

Low-pass filter. Removes components which are small in scale.



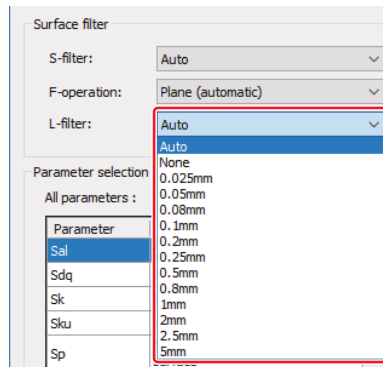
### <2> [F-operation] box

Sets the surface shape correction.



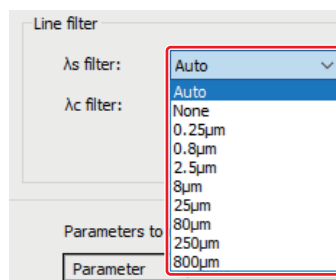
### <3> [ $\lambda$ -filter] box

High-pass filter. Removes the long components of waveform of waviness etc.



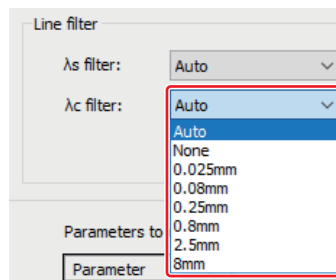
### <4> [ $\lambda_s$ filter] box

Sets the  $\lambda_s$  filter.



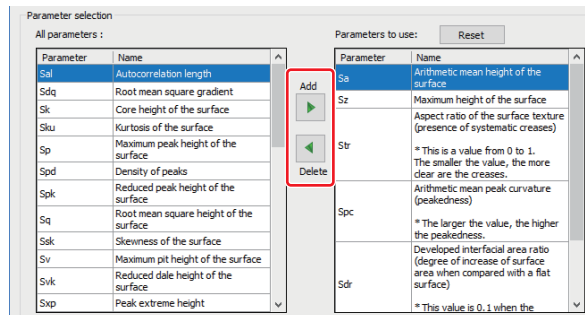
### <5> [ $\lambda_c$ filter] box

Sets the  $\lambda_c$  filter.



### <6> Arrow button

Selects a parameter.



### <7> [Reset] button

Clicking this button selects the default parameters (Sa, Str, Spc, Sz, Sdr, Ra, or RSm).

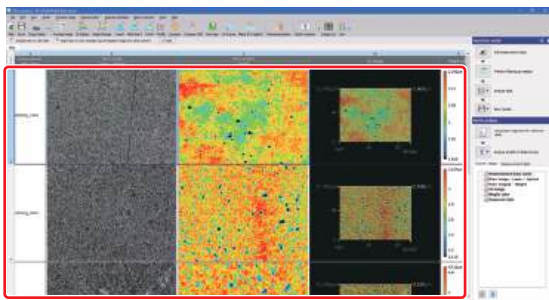
# Parameter Recommendation

Quantitatively compares 2 sample groups using multiple parameters and displays the degree of difference.

## Using the Recommendation Function

### 1 Open the measurement data or analysis result file for comparison.

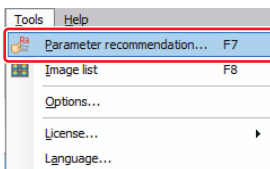
Opening/Closing File (Page 3-2)



### 2 Perform preprocessing as needed.

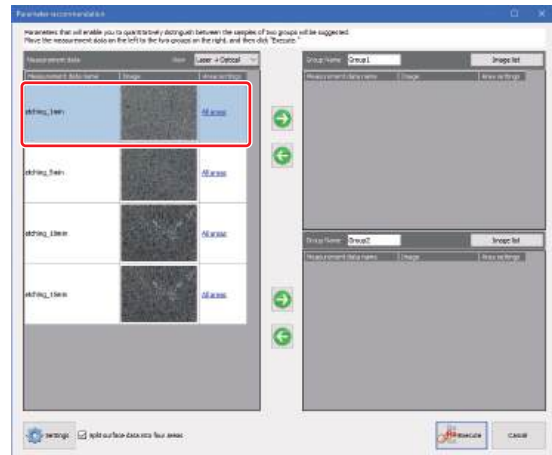
Measurement Preprocessing (Page 5-1)

### 3 Select [Parameter recommendation] from the [Tools] menu. Or click the [Recommendation] button on the toolbar.



The [Parameter recommendation] dialog box appears.

### 4 Click the measurement data to select.



Point

When the area settings field is clicked, the [Area Settings] dialog box is opened. Set [Rect] or [All areas] as needed.

Area Settings (Page A-2)

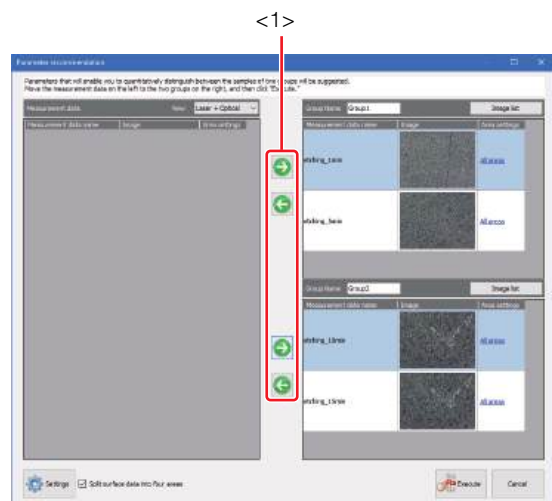
Reference

Click while pressing Ctrl or Shift to select multiple data.

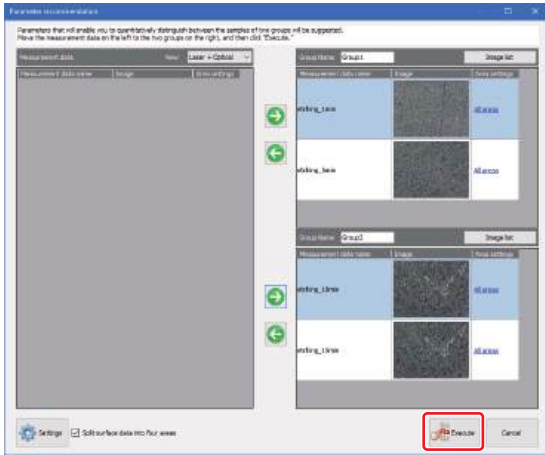
### 5 Click the arrow button (<1>), and distribute measurement data to be compared to group 1 or group 2.

Reference

You can also move the measurement data by dragging it.



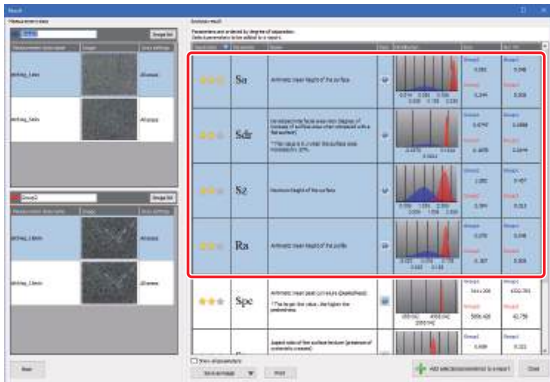
**6** Click the [Execute] button.



The [Result] dialog box appears after analysis.

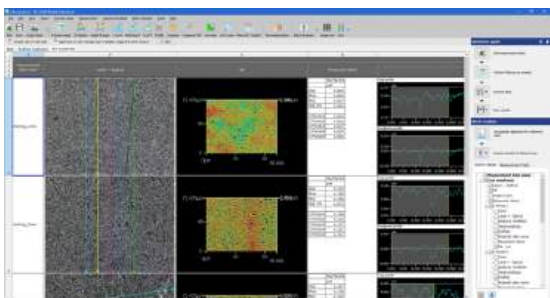
**7** Click and select the parameter row you want to add to the measurement items.

- Each time you click, the selection is switched.
- Multiple parameters can be selected.



**8** Click the [Add selected parameter(s) to a report] button.

According to the parameters, grid sheets of [Line roughness] and [Surface roughness] are added, and the results are displayed.



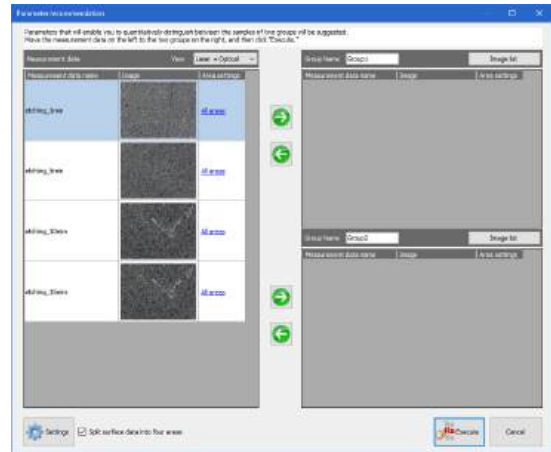
**Setting Parameters**

Change the parameter settings.

For details of each parameter, refer to [Roughness Definitions \(Page 10-14\)](#), [Surface Roughness Definitions \(Page 12-14\)](#).

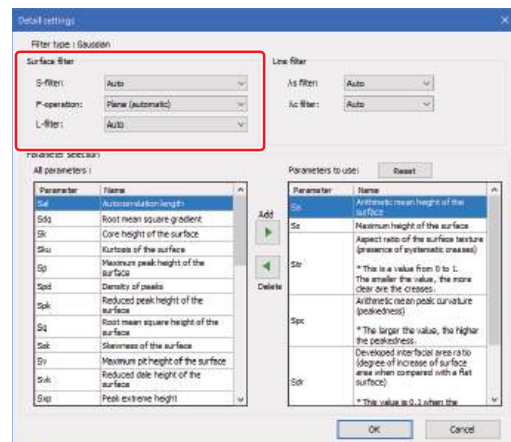
**1** Select [Parameter recommendation] from the [Tools] menu.

**2** Click the [Settings] button.

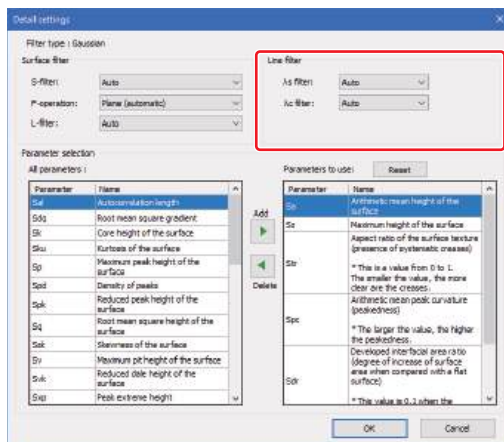


The [Detail settings] dialog box appears.

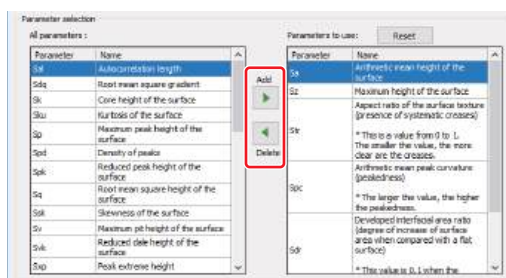
**3** Set [Surface filter].



#### 4 Set [Line filter].



#### 5 Click the arrow button, and select the parameter.



#### 6 Click the [OK] button.

Change parameter settings, and close the [Detail settings] dialog box.

## MEMO

# Chapter 15

## Comparative Measurement

This chapter describes the comparative measurement and 3D-CAD comparative measurement function found on the [Measurement] menu.

The comparative measurement determines the differences between profile graphs (such as cross-sectional area and height differences at specific points) by superimposing the profile graphs of two measurement data or 3D-CAD data and measurement data.



3D-CAD comparative measurement is an optional function.

To use this function, it is required to enable the CAD Comparison Module (VK-H3CA).

“License Registration Procedure for Analyzer Software Module”

Flow of Comparative Measurement .....	Page 15-2
Flow of 3D-CAD Comparative Measurement ...	Page 15-3
Screen Used for Comparative Measurement ...	Page 15-4
Comparative Measurement .....	Page 15-8

# Flow of Comparative Measurement

The flow of comparative measurement is as follows:

## Setup

### Selecting measurement data and reference data

- Select the reference data and measurement data used for comparative measurement in the grid sheet.

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Smoothing
- Noise removal
- C-DIC setting
- Leveling
- Height cut level
- Set invalid area
- Auto Position Adjustment
- Surface shape correction
- DCL/BCL
- Screen rotation
- Inverting an image
- Missing data removal
- Image trimming

☞ Chapter 5, Measurement Preprocessing (Page 5-1)

## Measurement

### Displaying reference data setting window

- Displays the reference data setting window to perform measurement.  
☞ Displaying Reference Data Setting Window (Comparative Measurement) (Page 15-8)

### Selecting reference data

- Select the reference data from the dropdown list.  
☞ Displaying Reference Data Setting Window (Comparative Measurement) (Page 15-8)

### Position adjustment of reference data

- Adjusts the position so that the measurement data and the reference data overlap.  
☞ Auto Position Alignment (Page 15-13)  
☞ 3 points designation position alignment (Page 15-14)  
☞ Tilt alignment (Page 15-15)  
☞ XY Position Alignment (Page 15-17)  
☞ Height offset alignment (Page 15-18)  
☞ Adjusting manually (Page 15-19)

### Setting height difference display

- You can set the height difference display.  
☞ Setting the Height Difference Display (Page 15-20)

### Profile line

- Draw a profile line at the measuring position of the measurement data and reference data displayed in the comparative measurement window. When a profile line is drawn, the profile graphs of the measurement data and reference data are superimposed.  
☞ Setting Profile Line (Page 15-21)

### Correcting profile graph

- As needed, perform a correction to cut the laser intensity level, correct the tilt, and remove the noise in the profile graph.  
☞ Correcting the DCL/BCL (Page 15-22)  
☞ Performing Smoothing (Page 15-23)  
☞ Correcting the Tilt of the Profile (Page 15-24)

### Setting measurement interval

- Sets measurement intervals on the profile graph to obtain measured values for each interval.  
☞ Setting Measurement Intervals (Page 15-25)

## Post-processing

### Exporting measurement result

- Output the measurement result to Excel file or create a report.  
☞ Exporting Analysis Result (Page 15-28)

# Flow of 3D-CAD Comparative Measurement

The flow of 3D-CAD comparative measurement is as follows:

## Setup

### Selecting 3D-CAD data and comparison images

- Select the measurement data used for 3D-CAD comparative measurement in the grid sheet.

### Measurement Preprocessing

Perform the following image processing as preprocessing for the measurement when needed.

- Reference plane settings
- Smoothing
- Noise removal
- C-DIC setting
- Leveling
- Height cut level
- Set invalid area
- Auto Position Adjustment
- Surface shape correction
- DCL/BCL
- Screen rotation
- Inverting an image
- Missing data removal
- Image trimming

Chapter 5, Measurement Preprocessing (Page 5-1)

## Measurement

### Displaying "Set Ref. image" dialog box

- Displays the "Set Ref. image" dialog box to perform the measurement.  
Displaying Reference Data Setting Window (3D-CAD Comparative Measurement) (Page 15-10)

### 3D-CAD data selection

- Selects the 3D-CAD data from the dropdown list to be the reference.  
Displaying Reference Data Setting Window (3D-CAD Comparative Measurement) (Page 15-10)

### Position adjustment of measurement data

- Adjusts the position so that the 3D-CAD data and the measurement data overlap.  
Auto Position Alignment (Page 15-13)  
3 points designation position alignment (Page 15-14)  
Tilt alignment (Page 15-15)  
XY Position Alignment (Page 15-17)  
Height offset alignment (Page 15-18)  
Adjusting manually (Page 15-19)

### Setting height difference display

- You can set the height difference display.  
Setting the Height Difference Display (Page 15-20)

### Setting profile line

- Draw a profile line at the measurement position of the 3D-CAD data and the measurement data displayed in the 3D-CAD comparative measurement window. When a profile line is drawn, the profile graphs of the 3D-CAD data and measurement data are superimposed.  
Setting Profile Line (Page 15-21)

### Correcting profile graph

- As needed, perform a correction to cut the laser intensity level, correct the tilt, and remove the noise in the profile graph.  
Correcting the DCL/BCL (Page 15-22)  
Performing Smoothing (Page 15-23)  
Correcting the Tilt of the Profile (Page 15-24)

### Setting measurement interval

- Sets measurement intervals on the profile graph to obtain measured values for each interval.  
Setting Measurement Intervals (Page 15-25)

## Post-processing

### Exporting measurement result

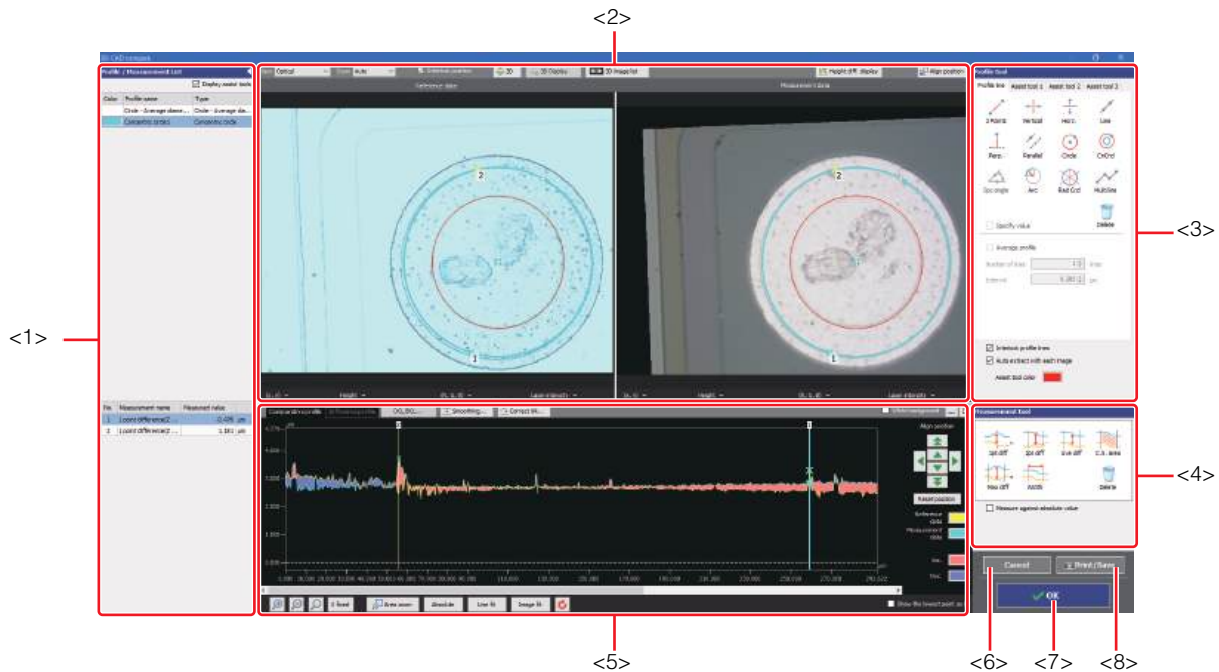
- Output the measurement result to Excel file or create a report.  
Exporting Analysis Result (Page 15-28)

# Screen Used for Comparative Measurement

Select [Compare] or [3D-CAD compare measurement] from the [Measurement] menu, or click [Compare] or [Compare CAD] button on the toolbar to display the selected comparative measurement window.

The following describes the name and functions of each part of the 3D-CAD comparative measurement window as an example.

\*The name of each part of the windows are common in both the comparative measurement and the 3D-CAD comparative measurement.



## <1> Profile/Measurement list

Displays the list of profiles and elements placed on the image display area and the list of measurement results.

📖 Profile/Measurement List (Page 15-5)

## <2> Image display area

Measurement data and reference data, or 3D-CAD data and measurement data are displayed. You can set measurement lines on this image. You can also change the display type and magnification of the image.

📖 Image Display Area (Page 15-6)

## <3> Profile tool

Contains buttons to draw various measurement lines, such as a straight line or a circle.

## <4> Measurement tool

Contains buttons used to measure the interval specified by the profile.

## <5> Profile display area

Displays the profile graph for the measurement line (or for the selected measurement line for the multi-line) on the image.

📖 Profile Display Area (Page 15-7)

## <6> [Cancel] button

By clicking, the [3D-CAD compare] window is closed without applying the setting contents.

## <7> [OK] button

By clicking, the [3D-CAD compare] window is closed, and the measurement result is applied in the grid sheet

## <8> [Print]/[Save] button

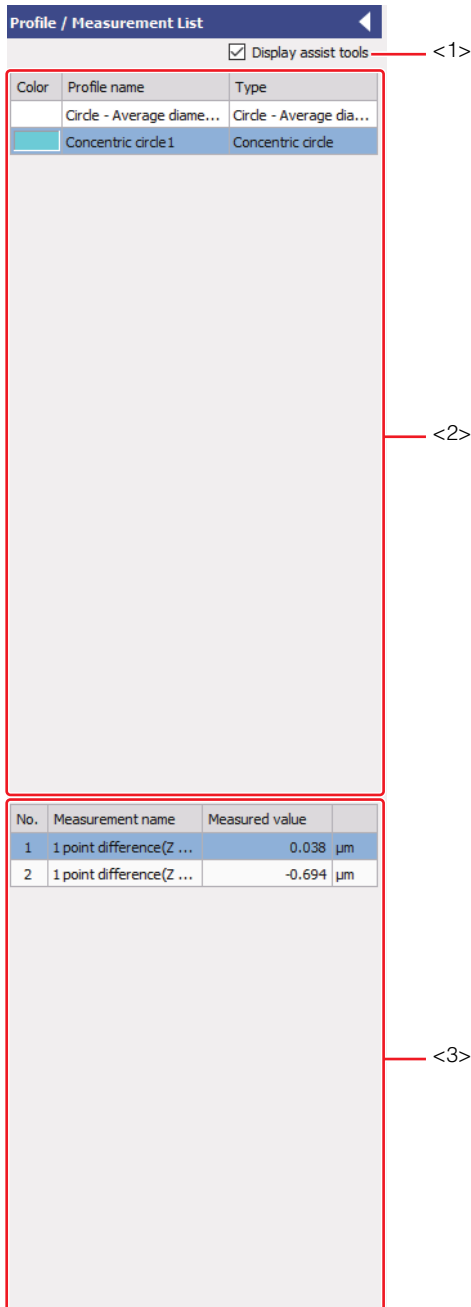
Output the screen display contents in the following formats.

- Save as image (PNG, JPEG, TIF)
- Copy to clipboard
- Print

📖 Outputting the Screen Display Contents (Page 6-11)

## Profile/Measurement List

The measurement list displays the list of profiles and elements placed on the image display area, and the list of measurement results.



### <1> [Display assist tools] checkbox

Selecting this checkbox displays the list of the assist tools in the profile list.

### <2> Profile list

Displays the list of profile lines and assist tools. The element being selected in the image display area is highlighted in this list.

### <3> Measured value list

Displays the following measured values of the selected profile in the image display area.

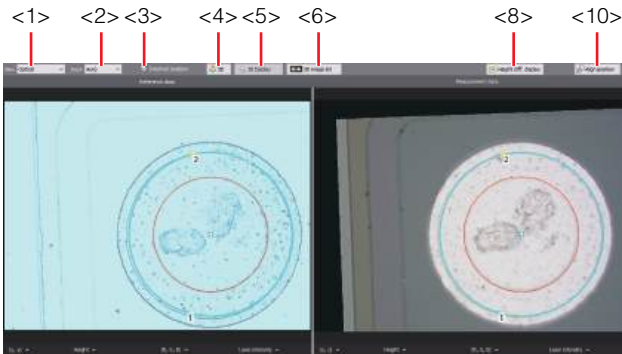
Item	Description
1 point difference	The height difference between the measurement data and reference data taken along the vertical cursor, or, the distance in the profile direction from the reference data to the measurement data.
2 point difference	The height difference between the measurement data and reference data taken along two vertical cursors.
Ave diff	The average height difference between the measurement data and reference data in between two vertical cursors.
C.S. area	The area between the measurement data and reference data measured between the two cursors.
Max diff	The maximum height difference between the measurement data and reference data in between two vertical cursors.
Width	The distance value between two vertical cursors in X direction.



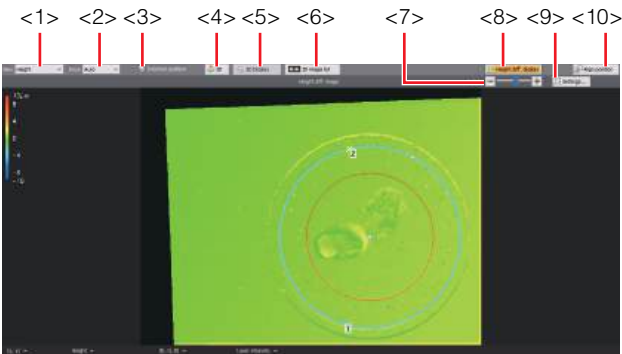
Click the button to collapse and hide the profile/measurement results list into the left edge of the window. Click the button to display it again.

## Image Display Area

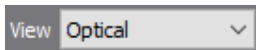
### ● When [Height diff. display] is OFF



### ● When [Height diff. display] is ON

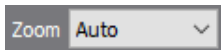


#### <1> [View] box



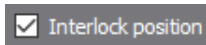
Select image type.

#### <2> [Zoom] box



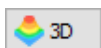
You can select a zoom level for the image.

#### <3> [Interlock position] checkbox



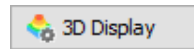
When this checkbox is selected, the reference data and the measurement data are linked during operation.

#### <4> [3D] button



Displays 3D image in the image display area.

#### <5> [3D display] button



Displays the [3D display] dialog box.

📖 Configuring Image Display (Page 4-4)



The [3D display] button can be clicked only when the 3D image is being displayed.

#### <6> [3D image list] button

Displays 3D image list in another window.

📖 Displaying the 3D Image List (Page 15-27)

#### <7> [Height diff.] slider bar

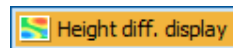


Set the upper limit and lower limit of the height difference.



The [Height diff.] slider bar appears only when the height difference is being displayed.

#### <8> [Height diff. display] button



When this button is ON, the height difference of the measurement data and the reference data will be displayed in the image display area.

#### <9> [Settings] button



Displays [Height diff. display setting] window, and enables setting of the height difference limits.

📖 Setting the Height Difference Display (Page 15-20)



The [Settings] button can be displayed only when the height difference is being displayed.

#### <10> [Align position] button

The [Set Reference data] dialog box appears.

📖 Displaying Reference Data Setting Window (Comparative Measurement) (Page 15-8)

📖 Displaying Reference Data Setting Window (3D-CAD Comparative Measurement) (Page 15-10)

## Profile Display Area



### <1> Profile display area

Displays the comparative profile graph or the difference profile graph obtained using the measurement line settings.

### <2> [Comparative profile] and [Difference profile] tabs

Switches the display between the comparative profile and difference profile.

### <3> [DCL/BCL] button

DCL (Dark Cut Level)/BCL (Bright Cut Level) interpolates the height data above the dark cut level (lower threshold) or the bright cut level (upper threshold) with the surrounding data when a portion of the laser intensity profile graph is judged as abnormal (too low or too high).

### <4> [Smoothing] button

Applies smoothing filter to the profile.

### <5> [Correct tilt] button

Corrects tilt on the measurement or reference data profile.

 Tilt alignment (Page 15-15)

### <6> Align position controls

After correction, finely adjust the position of the profile graph of the measurement data displayed in the profile display area up, down, left or right, so that it is superimposed on the profile graph wave shape of the reference data as much as possible.

### <7> Profile operation controls

Changes the method to view the profile graph.

### <8> Color palette

Changes colors of the profile graph of the reference data and the measurement data, as well as colors that indicate the increment and decrement.

# Comparative Measurement

## Displaying Reference Data Setting Window (Comparative Measurement)

Clicking on the [Compare] button displays the [Set Reference data] window.

### 1 Open the measurement data.

Opening/Closing File (Page 3-2)



**For comparative measurement, set a reference plane on the same plane to both the reference data and the measurement data in advance.**

**After selecting the reference data, the reference plane setting cannot be configured.**

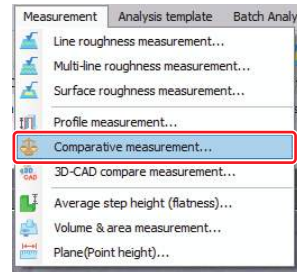
Reference Plane Settings (Page 5-3)



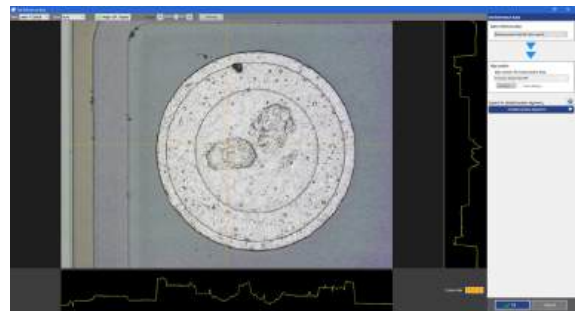
Perform the following preprocessing as needed.

- Reference Plane Settings  
Reference Plane Settings (Page 5-3)
- Leveling  
Leveling (Page 5-9)
- Surface shape correction  
Surface Shape Correction (Page 5-11)
- Inverting an Image  
Inverting an Image (Page 5-16)
- Smoothing  
Smoothing (Page 5-17)
- Height cut level  
Height Cut Level (Page 5-19)
- DCL/BCL  
DCL/BCL (Page 5-22)
- Missing data removal  
Missing Data Removal (Page 5-25)
- Noise removal  
Noise Removal (Page 5-26)
- Set invalid area  
Set invalid area (Page 5-28)
- Screen rotation  
Screen rotation (Page 5-29)
- Image trimming  
Image trimming (Page 5-30)
- C-DIC setting  
C-DIC setting (Page 5-32)
- Auto Position Adjustment  
Auto Position Alignment (Page 5-34)

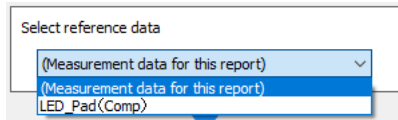
### 2 Select [Comparative measurement] from the [Measurement] menu. Or click the [Compare] button on the toolbar.



The [Set Reference data] dialog box appears.



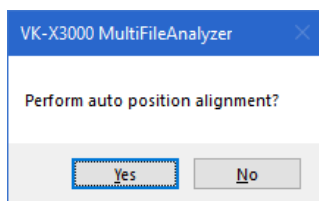
### 3 Select the reference data in the [Select reference data] box.



#### [Select reference data] box

You can select the reference data for automatic position adjustment from the opened measurement data.

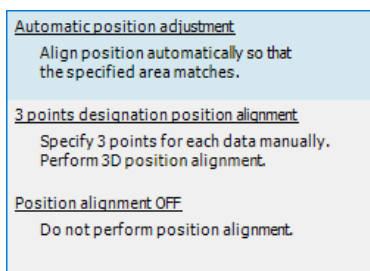
After selecting the data, the following dialog box appears.



Click [Yes] to align the position automatically.

Next, set common areas on the sample for automatic position adjustment.

### 4 Select a method for position alignment.



#### [Automatic position adjustment]

Aligns the position automatically so that it matches the specified area.

Auto Position Alignment (Page 15-13)

#### [3 points designation position alignment]

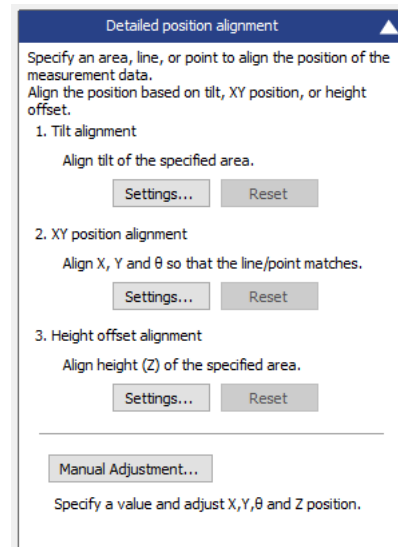
Specifies three points for each data and performs the 3D position alignment.

3 points designation position alignment (Page 15-14)

#### [Position alignment OFF]

The auto position alignment will not be performed.

### 5 When performing fine position alignment, click the [Detailed position alignment] button and select a method for position alignment.



#### [Tilt alignment]

Align tilt of the specified area.

Tilt alignment (Page 15-15)

#### [XY position alignment]

Aligns X, Y and  $\theta$  so that the line/point matches.

XY Position Alignment (Page 15-17)

#### [Height offset alignment]

Aligns the height of the specified area.

Height offset alignment (Page 15-18)

#### [Manual Adjustment]

Aligns the position manually.

Adjusting manually (Page 15-19)

### 6 Click the [OK] button.

The comparative measurement window appears.

## Displaying Reference Data Setting Window (3D-CAD Comparative Measurement)

Clicking on the [3D-CAD compare] button displays the [Set Reference data] window.

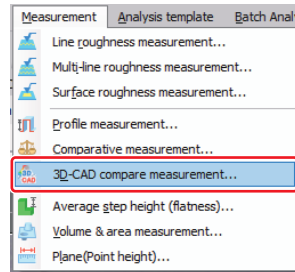
### 1 Open the measurement data.

Opening/Closing File (Page 3-2)

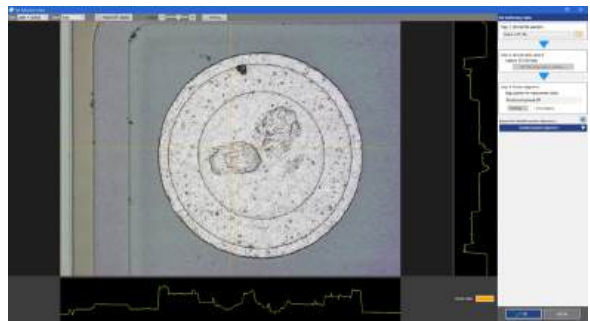
**Reference** Perform the following preprocessing as needed.

- Reference Plane Settings
  - ▢ Reference Plane Settings (Page 5-3)
- Leveling
  - ▢ Leveling (Page 5-9)
- Surface shape correction
  - ▢ Surface Shape Correction (Page 5-11)
- Inverting an Image
  - ▢ Inverting an Image (Page 5-16)
- Smoothing
  - ▢ Smoothing (Page 5-17)
- Height cut level
  - ▢ Height Cut Level (Page 5-19)
- DCL/BCL
  - ▢ DCL/BCL (Page 5-22)
- Missing data removal
  - ▢ Missing Data Removal (Page 5-25)
- Noise removal
  - ▢ Noise Removal (Page 5-26)
- Set invalid area
  - ▢ Set invalid area (Page 5-28)
- Screen rotation
  - ▢ Screen rotation (Page 5-29)
- Image trimming
  - ▢ Image trimming (Page 5-30)
- C-DIC setting
  - ▢ C-DIC setting (Page 5-32)
- Auto Position Adjustment
  - ▢ Auto Position Alignment (Page 5-34)

### 2 Select [3D-CAD compare measurement] from the [Measurement] menu. Or click the [Compare CAD] button on the toolbar.

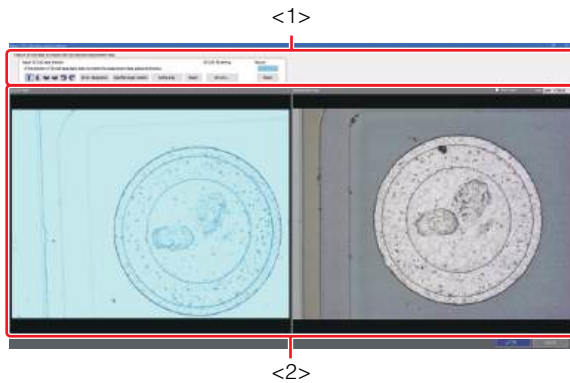


The [Set Reference data] dialog box appears.



### 3 Select an image set as a comparison target in the [3D-CAD file selection] box.

The [3D-CAD data capture setting] window appears.



#### <1> Main Tools

This tool bar includes buttons to configure the 3D-CAD data position direction.

#### [Adjust 3D-CAD data direction] tool

Changes the CAD data direction.

#### [3D-CAD file setting] tool

Click the [Set unit] button to set the unit for CAD data.

#### [Texture] tool

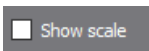
When the texture is displayed, the display color of CAD data can be set.

To return to the previous color, click the [Reset] button.

#### <2> Image display area

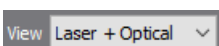
Displays the main image and CAD data in the image display window.

#### [Show scale] checkbox



Select to show the scale on the lower right of the display area.

#### [View] box



Select image type.

### 4 Use different tools to adjust the direction of the 3D-CAD data so that it matches the measurement data.

- When the [Rotation] button is used



Click your desired direction button to rotate the image in that direction 90 degrees.

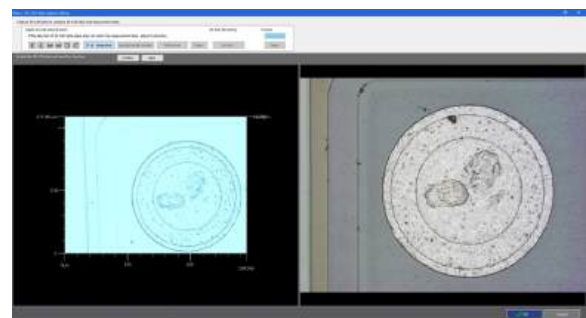
- When the [3D dir. designation] button is used



Click the [3D dir. designation] button to rotate the image on the image display area.

Drag the mouse and rotate the image.

After the rotation, click the [Confirm] button to determine the direction.



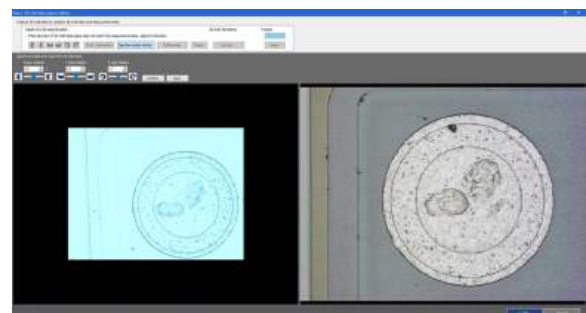
- When the [Specified angle rotation] button is used



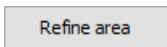
Click the [Specified angle rotation] button to rotate the image in a specified angle.

Specify a value in [X axis rotation], [Y axis rotation] and [Z axis rotation], and rotate the image.

After the rotation, click the [Confirm] button to determine the direction.

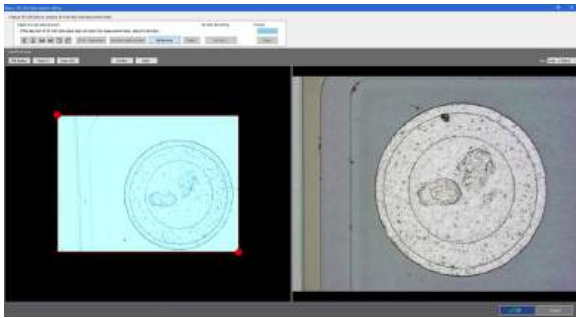


- When the [Refine area] button is used



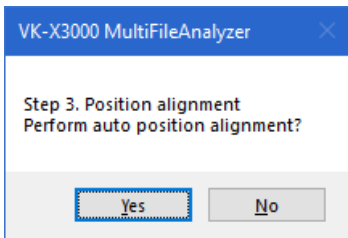
Click the [Refine area] button to refine the CAD data display area on the image display area.

After the display area is determined, click the [Confirm] button to determine the area.



## 5 Click the [OK] button.

The following dialog box appears.



Click [Yes] to align the position automatically.

Next, set common areas on the sample for automatic position adjustment.

## 6 Select a method for position alignment.

### [Automatic position adjustment]

Aligns the position automatically so that it matches the specified area.

Performing Position Alignment (Page 15-13)

### [3 points designation position alignment]

Specifies three points for each data and performs the 3D position alignment.

3 points designation position alignment (Page 15-14)

### [Position alignment OFF]

The auto position alignment will not be performed.

## 7 When performing fine position alignment, click the [Detailed position alignment] button and select a method for position alignment.

### [Tilt alignment]

Align tilt of the specified area.

Tilt alignment (Page 15-15)

### [XY position alignment]

Aligns X, Y and  $\theta$  so that the line/point matches.

XY Position Alignment (Page 15-17)

### [Height offset alignment]

Aligns the height of the specified area.

Height offset alignment (Page 15-18)

### [Manual Adjustment]

Aligns the position manually.

Adjusting manually (Page 15-19)

## 8 Click the [OK] button.

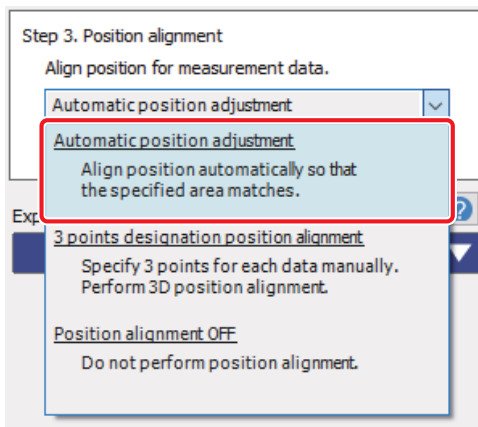
The comparative measurement window appears.

## Performing Position Alignment

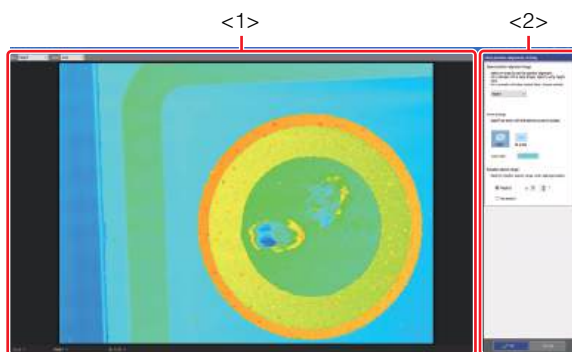
### Auto Position Alignment

Aligns the position automatically so that it matches the specified area.

- 1 Select **[Automatic position adjustment]** from the **[Position alignment]** pull-down list.



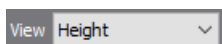
The [Auto position alignment setting] window appears.



#### <1> Image display area

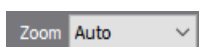
Displays 3D-CAD data.

#### [View] box



Select image type.

#### [Zoom] box

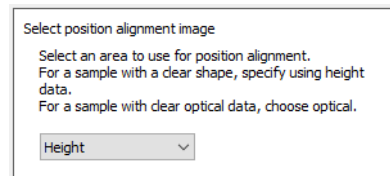


You can select a zoom level for the image.

#### <2> Main Tools

This tool bar includes buttons to configure auto position alignment.

- 2 Select an image type for the image used for position alignment by the **[Select position alignment image]** box.



#### [Height]

Uses the height data to align the position.

#### [Laser]

Uses the laser data to align the position.

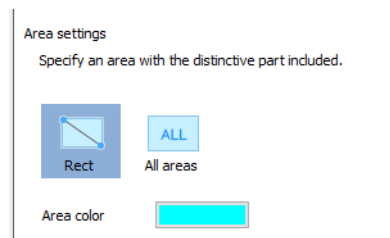
#### [Laser intens]

Uses the laser intensity data to align the position.

#### [Optical]

Uses the color data to align the position.

- 3 Select the area on which the auto position alignment is performed by the **[Area settings]** tool.



#### [Rect] button

Selects a rectangle area.

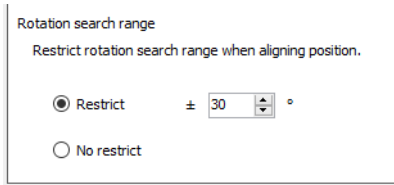
#### [All areas] button

Select entire image.

#### [Area color] button

Selects an area color for the position alignment displayed in [Image display area].

**4 Restrict the rotation search range by the [Rotation search range] radio button as needed.**



**[Restrict] radio button**

Restricts the rotation search range while performing position alignment.

**[Rotation search range] box**

Determines the search range while performing rotation search.

**[No restrict] radio button**

Does not restrict the rotation search range while performing position alignment.

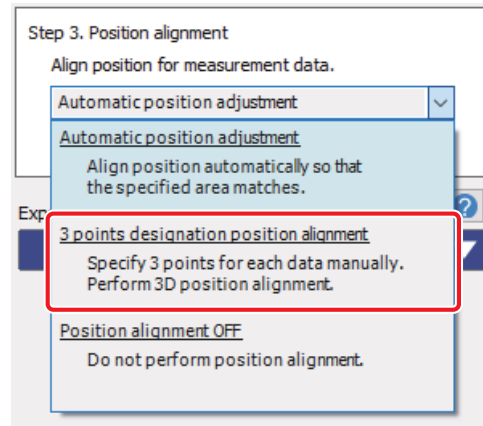
**5 Click the [OK] button.**

Aligns the position automatically so that it matches the specified area.

**3 points designation position alignment**

Specifies three points for each data and performs the 3D position alignment.

**1 Select [3 points designation position alignment] from the [Position Alignment] pull-down list.**



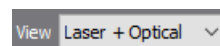
The [3 points designation position alignment setting] window appears.



**<1> Image display area**

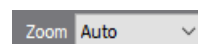
Reference data and measurement data, or 3D-CAD data and measurement data are displayed.

**[View] box**



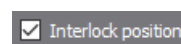
Select image type.

**[Zoom] box**



You can select a zoom level for the image.

**[Interlock position] checkbox**



When this checkbox is selected, the reference data and measurement data, or 3D-CAD data and measurement data are linked during operating.


## <2> Main Tools

This tool bar includes buttons to configure the position alignment setting.

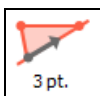
## 2 Select the [Assist tool 1] tab or [Assist tool 2] tab, and click the desired button to place an element on the image as needed.

A line used for position alignment can be generated by point and line elements. If you place these elements on the measurement position in advance using the assist tool, you can perform the position alignment accurately and efficiently in a way that is similar to actual drawing.


 What is an Element? (Page A-22)

 How to use the assist tool (Page A-33)

## 3 Press the [3 pt.] button to specify three points for position alignment.



Three points for performing position alignment can be specified.

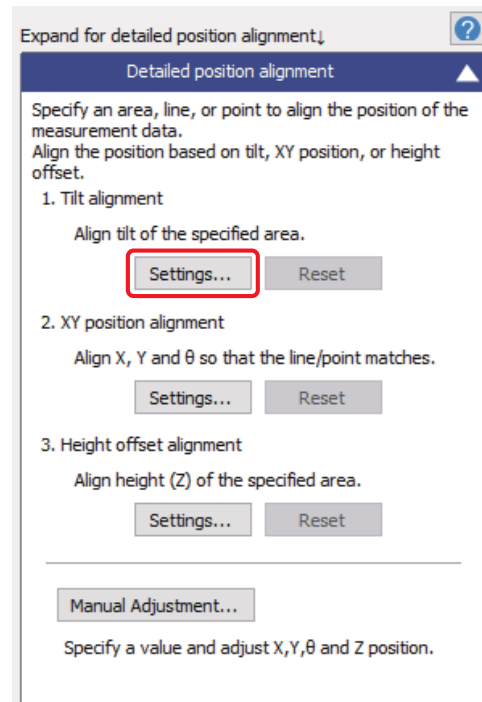
 When you want to confirm the position alignment place by 3D image, click the [3D] button.

## 4 Press the [OK] button.

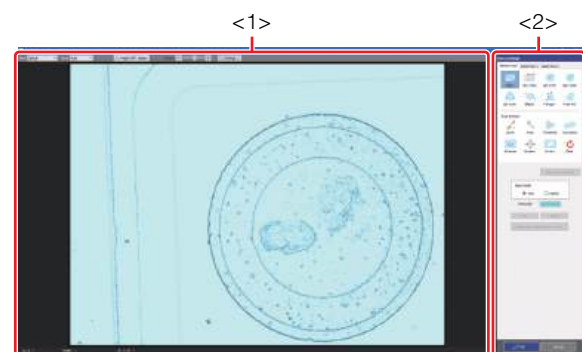
Perform 3D position alignment.

## Tilt alignment

### 1 Click the [Settings] button in the [Tilt alignment] area.



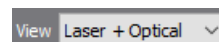
The [Set tilt alignment] window is displayed.



### <1> Image display area

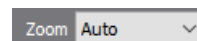
Reference data or 3D-CAD data are displayed.

### [View] box

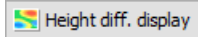


Select image type.

### [Zoom] box



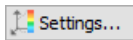
You can select a zoom level for the image.

**[Height diff. display] button**

When this button is ON, the height difference of the reference data and measurement data, or 3D-CAD data and measurement data will be displayed in the image display area.

**[Height diff.] slider bar**

Set the upper limit and lower limit of the height difference.

**[Settings] button**

Displays [Height diff. display setting] window, and enables setting of the height difference limits.

Setting the Height Difference Display (Page 15-20)

**<2> Main Tools**

This tool bar includes buttons to configure the tilt alignment setting.

## 2 Select the [Assist tool 1] tab or [Assist tool 2] tab, and click the desired button to place an element on the image as needed.

A line used for position alignment can be generated by point and line elements. If you place these elements on the measurement position in advance using the assist tool, you can perform the position alignment accurately and efficiently in a way that is similar to actual drawing.

What is an Element? (Page A-22)

How to use the assist tool (Page A-33)

## 3 Select [Element tool] and click the desired button to place the element on the image.

Area Settings (Page A-2)



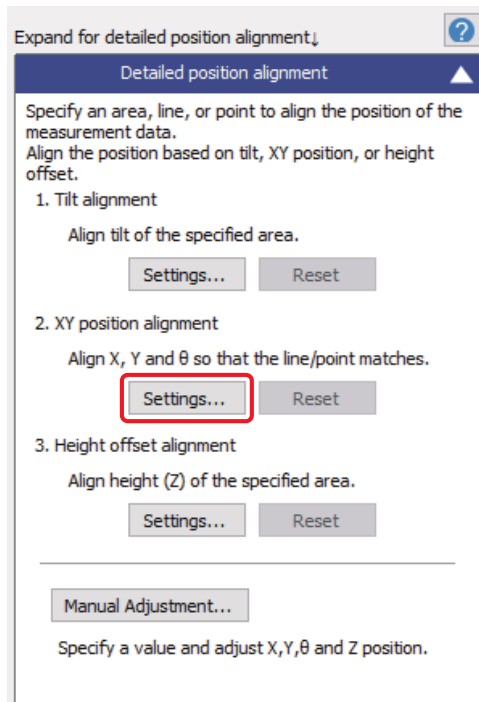
- When the [Previously set area] button is clicked, the edited area returns to the state when the [Set tilt alignment] window is displayed.
- The method of editing the element can be changed by switching the [Input mode] radio button.
  - [Add] radio button  
If an element is placed, the specified area will be added.
  - [Delete] radio button  
If an element is placed, the specified area will be removed from the existing area.
- Click the [Undo] button to return to the previous step of area setting operation.
- Click the [Redo] button to restore the operation you canceled with the [Undo] button.
- Clicking the [Display the area failed to restore] button displays the [An area failed to restore] window.

## 4 Click the [OK] button.

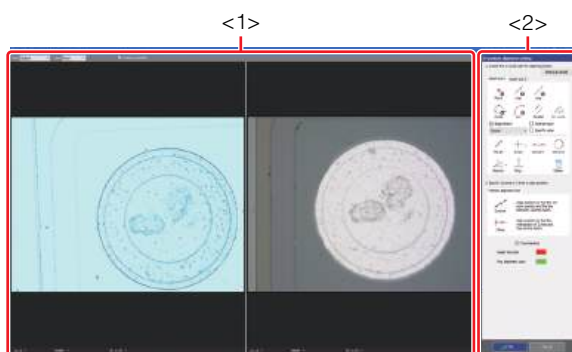
Perform the tilt alignment.

## XY Position Alignment

- 1 Click the **[Settings]** button in the **[XY position alignment]** area.



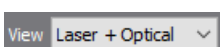
The [XY position alignment setting] window appears.



### <1> Image display area

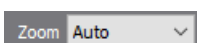
Reference data and measurement data, or 3D-CAD data and measurement data are displayed.

### [View] box



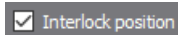
Select image type.

### [Zoom] box



You can select a zoom level for the image.

### [Interlock position] checkbox



When this checkbox is selected, the reference data and measurement data, or 3D-CAD data and measurement data are linked during operating.

### <2> Main Tools

This tool bar includes buttons to configure the XY position alignment setting.

- 2 Select the **[Assist tool 1]** tab or **[Assist tool 2]** tab, and click the desired button to place an element on the image as needed.

A line used for position alignment can be generated by point and line elements. If you place these elements on the measurement position in advance using the assist tool, you can perform the position alignment accurately and efficiently in a way that is similar to actual drawing.

What is an Element? (Page A-22)

How to use the assist tool (Page A-33)

- 3 Select **[Position alignment tool]**, and click the desired button to place the element on the image.



Align the position so that the 1st point and the line between the two points match.



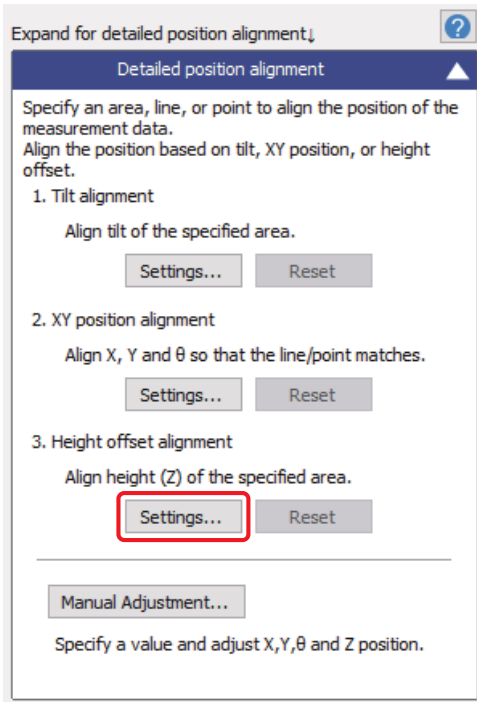
Align the position so that the intersection of two lines and the 1st line match.

- 4 Click the **[OK]** button.

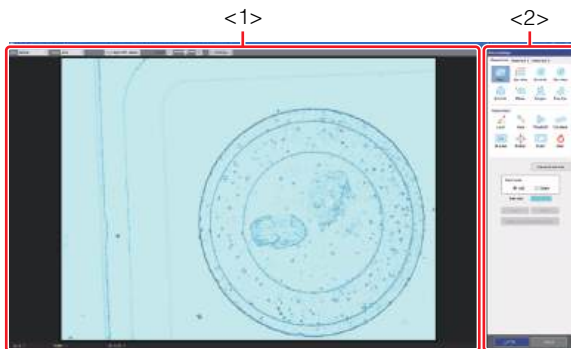
Perform XY position alignment.

## Height offset alignment

- 1 Click the **[Settings]** button in the **[Height offset alignment]** area.



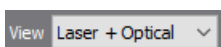
The **[Height offset alignment area setting]** window appears.



### <1> Image display area

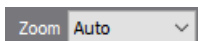
Reference data or 3D-CAD data are displayed.

#### [View] box



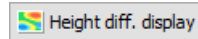
Select image type.

#### [Zoom] box



You can select a zoom level for the image.

#### [Height diff. display] button



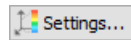
When this button is ON, the height difference of the reference data and measurement data, or 3D-CAD data and measurement data will be displayed in the image display area.

#### [Height diff.] slider bar



Set the upper limit and lower limit of the height difference.

#### [Settings] button



Displays **[Height diff. display setting]** window, and enables setting of the height difference limits.

Setting the Height Difference Display (Page 15-20)

### <2> Main Tools

This tool bar includes buttons to configure the tilt alignment setting.

- 2 Select the **[Assist tool 1]** tab or **[Assist tool 2]** tab, and click the desired button to place an element on the image as needed.

A line used for position alignment can be generated by point and line elements. If you place these elements on the measurement position in advance using the assist tool, you can perform the position alignment accurately and efficiently in a way that is similar to actual drawing.

What is an Element? (Page A-22)

How to use the assist tool (Page A-33)

### 3 Select [Element tool] and click the desired button to place the element on the image.

Area Settings Tool (Page A-2)

Point

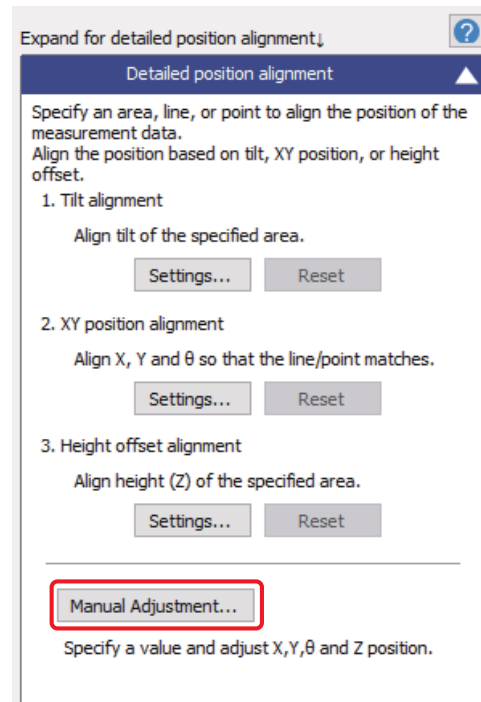
- When the [Previously set area] button is clicked, the edited area returns to the state when the [Height offset alignment] window is displayed.
- The method of editing the element can be changed by switching the [Input mode] radio button.
  - [Add] radio button  
If an element is placed, the specified area will be added.
  - [Delete] radio button  
If an element is placed, the specified area will be removed from the existing area.
- Click the [Undo] button to return to the previous step of area setting operation.
- Click the [Redo] button to restore the operation you canceled with the [Undo] button.
- Clicking the [Display the area failed to restore] button displays the [An area failed to restore] window.

### 4 Click the [OK] button.

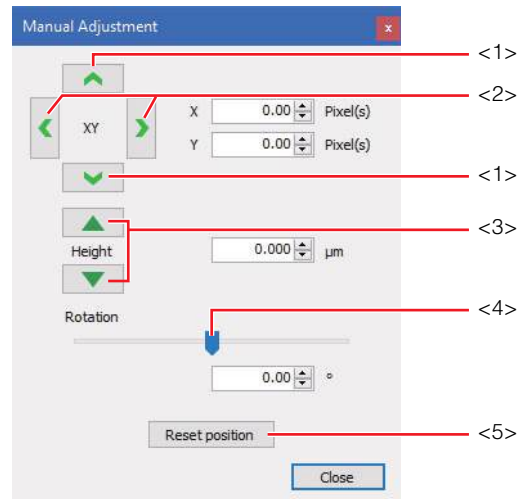
Performs the height offset alignment.

## Adjusting manually

### 1 Click the [Manual Adjustment] button.



### 2 Adjust positions looking at the profile graph.



#### <1> XY adjustment buttons (up and down)

Move the measurement data up and down.  
According to the movement, the profile graph of the measurement data (blue) moves.

#### <2> XY adjustment buttons (right and left)

Move the measurement data left and right.  
According to the movement, the profile graph of the measurement data (blue) moves.

**<3> Height adjustment buttons**

The lower profile graph (blue) moves up and down, and the right profile graph (blue) moves right and left. Make each profile graph overlaps as much as possible.

**<4> Rotation slider**

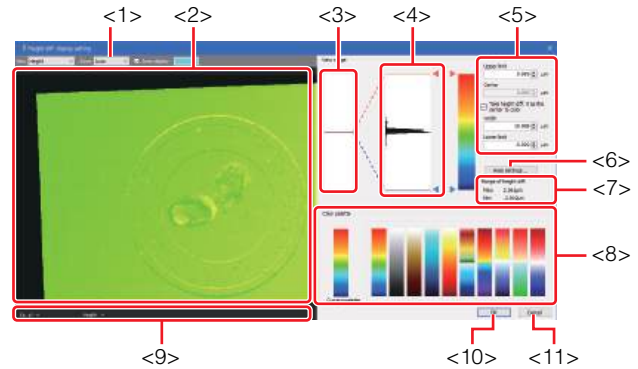
Rotates the measurement data.

**<5> [Reset position] button**

Cancels the manual adjustment, and it returns to the previous state before manual adjustment.

## Setting the Height Difference Display

You can set the height difference display.

**<1> [Zoom] box**

You can select a zoom level for the image.

**<2> Image display area**

The image is displayed in this area.

**<3> Full-scale display range**

Specifies the height range of the sample and displays with 256 step gradation. In other words, specify what range of the height difference is to be displayed with 256 step gradation.

To do so, drag the red (for the upper limit) and blue (for the lower limit) cursors on the frame to set the range.

**<4> 256 step display range**

Specifies the upper and lower limits of the height data within the 256 step display range.

To do so, drag the red (for the upper limit) and blue (for the lower limit) cursors on the frame to set the range.

**<5> Upper limit, center, width and lower limit****[Upper limit] box**

Shows the upper limit value specified in the 256 step display range.

**[Center] box**

Shows the center value between the upper and lower limits of the specified range.

**[Take height diff. 0 as the center to color] checkbox**

Select to set the center value to 0. The [Center] box will be grayed out.

**[Width] box**

Shows the width of the range specified with the upper and lower limits.

**[Lower limit] box**

Shows the lower limit value specified in the 256 step display range.

**<6> [Area settings] button**

Select and use the displayed [Area settings] window to specify the area of the height display.

The values between the maximum and minimum height data in the specified area are displayed with 256 step gradation.

**<7> Range of height difference values**

Shows the maximum or minimum values for the height difference.

**<8> Color palette**

Selects the color palette which displays the height difference image.

**<9> Status bar**

Displays the X and Y coordinates and height difference at the mouse pointer placed in the image display area.

**1 Set the height difference.**

There are two methods shown below to configure the settings.

**Convert by value**

Enter numerical values in the [Upper limit], [Center], [Width] and [Lower limit] boxes to display the corresponding height data in the range specified in 256 step gradation. This method allows you to display multiple samples with the same step gradation (the same standard levels of gradation). Changing the value of [Center] while keeping [Width] constant adjusts the setting with the specified range (the range between the upper and lower limits) kept unchanged.


Changing the value of [Width] while keeping [Center] constant enables free adjustments of the specified range (the upper and lower limits).

**Setting with the cursors of the upper and lower limits**

Drag the upper limit (red) and lower limit (blue) cursors of the height data histograms to set a corresponding 256 step gradation.

**2 Click the [OK] button (<10>).**

The [Height diff. display setting] window closes, and the display settings are applied to the height difference image.

 By clicking the [Cancel] button (<11>), the [Height diff. display setting] window is closed without applying the setting contents.


**Setting Profile Line**

Set a profile line at the measurement position on the image displayed in the comparative measurement window. When the profile line is specified on the image, a profile graph at the measurement position is displayed.

**1 Select the [Assist tool 1] tab, [Assist tool 2], or [Assist tool 3] tab in the profile tool, and click the desired button to place an element on the image as needed.**

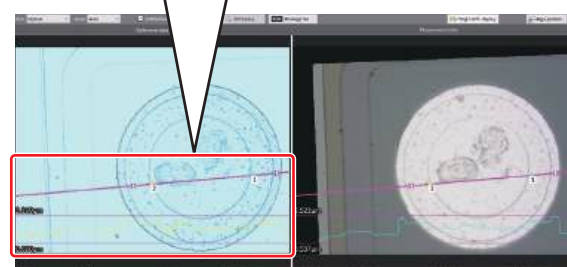
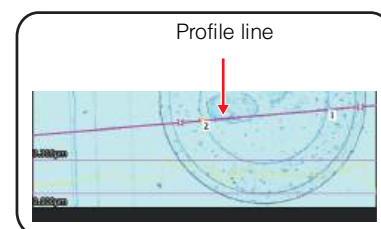
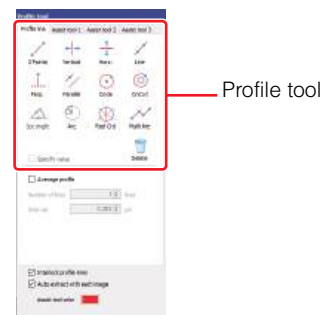
A measurement line consists of elements such as points and lines. If you place these elements on the measurement position in advance using the buttons on the [Assist tool 1] tab, [Assist tool 2] tab, or [Assist tool 3] tab, you can draw a measurement line accurately and efficiently in a way that is similar to actual drawing.

 What is an Element? (Page A-22)

 How to use the assist tool (Page A-33)

**2 Click the desired button on the [Profile line] tab in the profile tool and draw a measurement line on the image.**

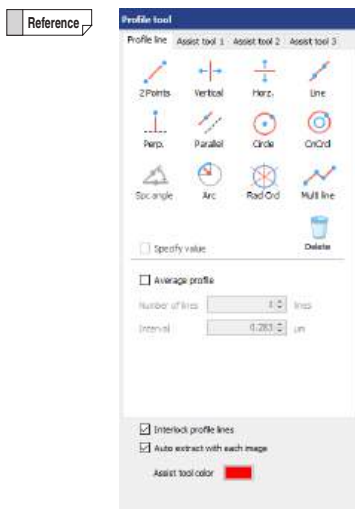
 How to use profile line tool (Page A-26)



When you draw a profile line on one image, the profile line is drawn on the other image too, and an actual cross-sectional graph is displayed in the profile display area.

Because the profile graph is updated in real time during the drawing process of the profile line, you can draw the measurement line while confirming the waveform.

Additionally, the Profile/Measurement List displays the profile list.



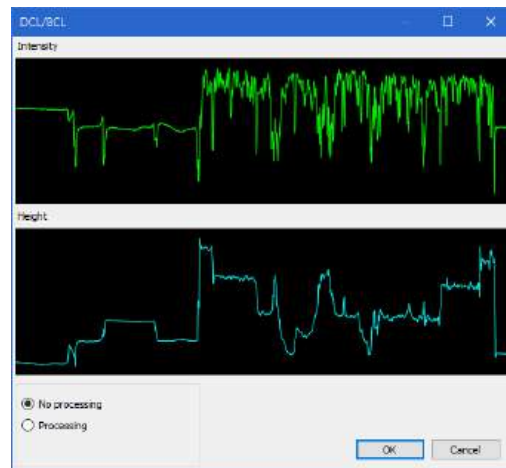
- When the [Interlock profile lines] checkbox is selected, moving the profile line in the reference data will also move the profile line to the same position within the measurement data.
- When the [Auto extract with each image] checkbox is selected, the assist tool is extracted automatically on the reference data and the measurement data. When this checkbox is deselected, the result extracted automatically on the image with the assist tool placed is applied to both images.

## Correcting the DCL/BCL

DCL (Dark Cut Level)/BCL (Bright Cut Level) cuts the laser intensity level above the dark cut level (lower threshold) or the bright cut level (upper threshold) with the surrounding data when a portion of the laser intensity of the laser intensity profile graph is judged as abnormal (too low or too high).

- 1 Click the [DCL/BCL] button in the profile display area, and click [Reference data profile] or [Measurement data profile].

The [DCL/BCL] window appears.



- 2 Click the [Processing] radio button.

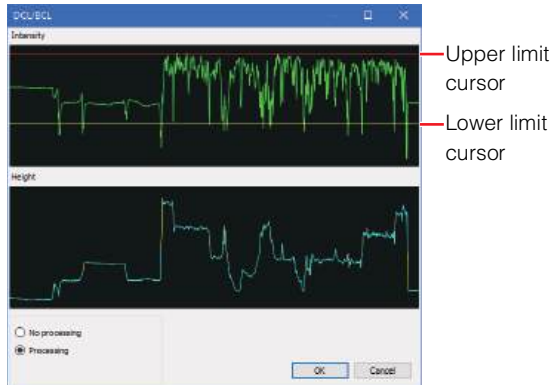
### [No processing] radio button

The changes in DCL/BCL are not reflected in the display.

### [Processing] radio button

Smooths height data (cross section Profile) by smoothing and cutting level processing.

### 3 Drag the upper limit and lower limit cursors to set the threshold.



The height profile graph after correction is displayed in the [DCL/BCL] window.

#### Upper limit cursor

The laser intensity data higher than the cursor will be cut (bright areas).

#### Lower limit cursor

The laser intensity data lower than the cursor will be cut (dark areas).

### 4 Click the [OK] button in the [DCL/BCL] window.

This executes the correction.

## Performing Smoothing

The smoothing operation makes a waveform of graph smoother by averaging measured data.

### 1 Click the [Smoothing] button in the profile display area, and click [Reference data profile] or [Measurement data profile].

The [Smoothing] window appears.



### 2 Select a filter type.

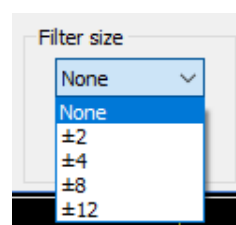
#### [Simple average] radio button

Simply averages the height data in the intervals specified in [Filter size]. This averaging method greatly reduces noise, but profiles, such as edges, become softer as well.

#### [Average weight] radio button

Multiplies height data in the intervals specified in [Filter size] by a weighting factor, and then performs calculation. This averaging method makes shapes smoother, preserving the sharpness of edges as much as possible.

### 3 Select a filter size.



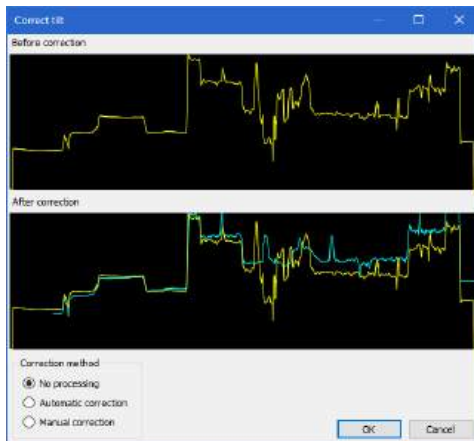
### 4 Click the [OK] button in the [Smoothing] window.

This executes the correction.

## Correcting the Tilt of the Profile

- 1 Click the **[Correct tilt]** button in the profile display area, and click **[Reference data profile]** or **[Measurement data profile]**.

The **[Correct tilt]** window appears.



### Before correction

The profile graph before correction appears.

### After correction

The profile graph after correction appears.

- 2 Select the correction method.

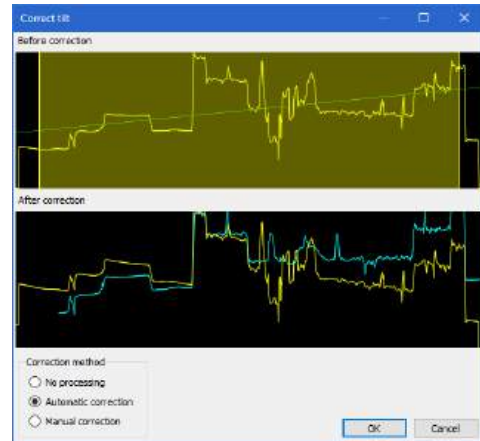
When selecting the correction method, the straight line to show the tilt of the profile is displayed.

### [No processing] radio button

Restores the tilt correction once set back to the original state.

### [Automatic correction] radio button

Automatically corrects to make the area surrounded by the vertical cursors horizontal on the profile graph of **[Before correction]**.



### [Manual correction] radio button

The yellow markers are displayed on the graph before correction. Drag these two point markers to adjust the tilt.

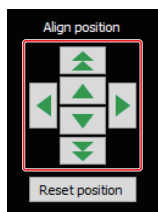
- 3 Click the **[OK]** button in the **[Correct tilt]** window.

The tilt correction is executed.

## Adjusting the Position of Profile Graph for the measurement data

After correction, finely adjust the position of the profile graph of the measurement data displayed in the profile display area up, down, left or right, so that it is superimposed on the profile graph wave shape of the reference data as much as possible.

- 1 **Finely adjust the position of the profile graph of the measurement data up, down, left or right by using the arrows.**



### Arrows

 : Moves the profile graph in large steps.

 : Moves the profile graph in small steps.

### Resetting the position adjustment

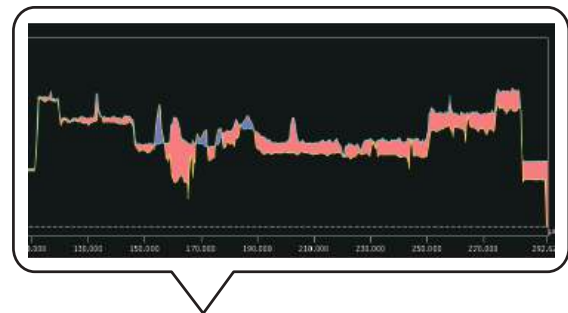
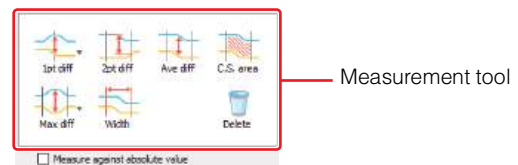
Click the [Reset position] button to reset the adjusted profile graph position.

## Setting Measurement Intervals

Set measurement intervals on the profile displayed on the profile display area, and obtain measurement values for each measurement interval.

- 1 **Click the desired button in the measurement tool and set a measurement interval on a profile.**

 How to use measurement tool (Page A-55)



When a measurement interval is set on a profile, the measured value appears in the profile/measurement list.

## Changing the method to view the profile graph

You can enlarge/reduce/fit a view of a profile graph by clicking each button in the profile operation controls.

The following describes the functions of each button.



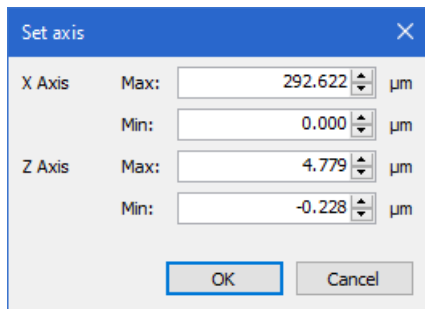
Enlarges 1.5 times the original magnification. This is the same as [Enlarge] in the right-click menu.



Reduces 2/3 times the original magnification. This is the same as [Reduce] in the right-click menu.



Displays the [Set axis] dialog box for the comparative measurement.



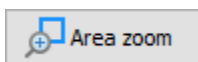
In the [Set axis] dialog box, you can set a display area for each of the X and Z axis with the maximum and minimum values.

If the [Match Z axis to X axis scale] checkbox is selected, the maximum value of the Z axis is adjusted to make the aspect ratio 1:1 based on the X axis.

- **[X fixed] button**

Fixes the scaling of the X axis of the profile.

- **[Area zoom] button**



Specifies a rectangular area on the profile graph by dragging the mouse, then the profile graph in the specified rectangular area is enlarged to fit to the entire profile display area.

- **[Absolute] button**

Adjust the scaling of the Z axis to make the aspect ratio 1:1 based on the X axis of the profile.

- **[Line fit] button**

Enlarges or reduces the entire profile graph to fit it to the entire profile display area.

- **[Image fit] button**

Adjust the maximum or minimum of the Z axis in the profile display area to the maximum or minimum of the entire height image. Or adjust the X axis to fit the profile graph to the entire profile display area.

- **[Reset] button**



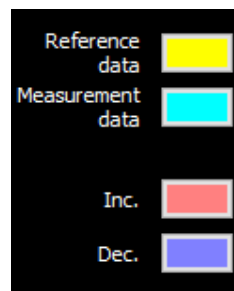
Resets the scaling of the X and Z axes.

- **[Show the lowest point as 0] checkbox**

The scaling of the Z axis is adjusted with the lowest point of the profile graph set to 0.

## Setting the color of the profile graph

Click the [Reference data], [Measurement data], [Inc.], or [Dec.] color palette to select a color for the profile graph.



## Applying the Measurement Result in the Main Screen

- 1 **Click the [OK] button in the comparative measurement window.**

The comparative measurement window is closed, and the measurement result is applied in the grid sheet.



By clicking the [Cancel] button, the comparative measurement window is closed without applying the setting contents.

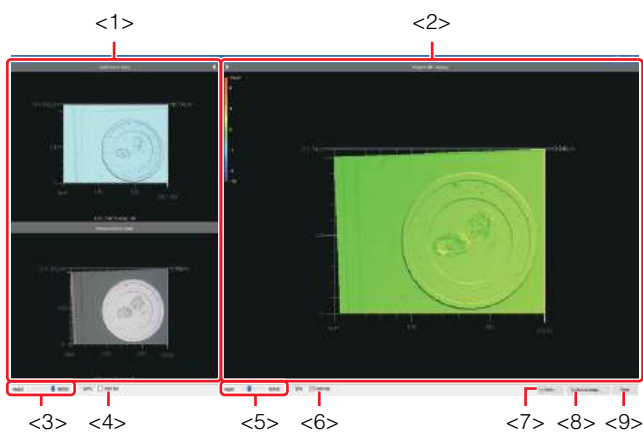
## Operating the Grid View Area

Measurement data information and measurement analysis results are displayed on the grid view area. For setting the display contents, see the following.

- 📖 Grid view area (Page 2-8)
- 📖 Inserting items (Page 2-11)
- 📖 Sorting (Page 2-12)


## Displaying the 3D Image List

The 3D images of reference data, measurement data and height difference display data can be displayed in a list. The displayed data can be printed or output as an image.



### <1> Reference data/measurement data display area


This area displays 3D image of the reference data and measurement data.

After clicking , the display area is hidden and the [Reference data, measurement data] button is displayed on the top screen.

Click the [Reference data, measurement data] button to display the reference data/measurement data display area.

### <2> Height difference image display area

Displays the 3D image of the height difference display data.

After clicking , the display area is hidden and the [Height diff. display] button is displayed on the top screen.

Click the [Height diff. display] button to display the height difference image display area.

### <3> [Height/Optical] slider bar

Sets the percentage of the texture which composes the surface of 3D image of the reference data and measurement data.

The larger the value, the more texture is displayed on the surface.

The smaller the value, the more height color data is displayed.

### <4> [Color bar] checkbox

Select to show the color bar on the upper right of the reference data/measurement data display area.

### <5> [Height/Optical] slider bar

Sets the percentage of the texture which composes the surface of 3D image of the height difference display data.

The larger the value, the more texture is displayed on the surface.

The smaller the value, the more height color data is displayed.

### <6> [Color bar] checkbox

Select to show the color bar on the upper right of the height difference image display area.

### <7> [Print] button

The images being displayed will be printed.

The images not being displayed will not be printed.

### <8> [Save as image] button

The images being displayed will be saved as one image.

The images not being displayed will not be saved.

### <9> [Close] button

Closes the [3D image list] window.

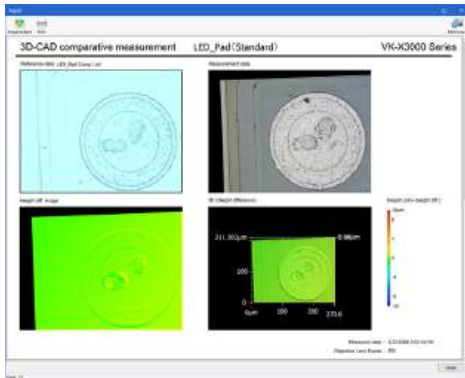
## Exporting Analysis Result

The comparative measurement analysis results can be output to a report or Excel file.

### ● Report output

Outputs the results in a defined format in another window.


Refer to  Report (Page 3-9).



### ● Exporting to Excel file

Outputs the image data and text to Excel in grid display layout.


Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to  Exporting as Excel File (Page 3-15).

### ● Save CSV

Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

Refer to  Exporting measurement result (Page 3-13).

# Chapter 16

## Batch Analysis

This chapter describes the function that applies analysis processing to multiple measurement data.

Batch Height Range Settings .....	Page 16-2
Batch Graph Range Settings .....	Page 16-3
Unify position alignment/image processing/ measurement details .....	Page 16-4

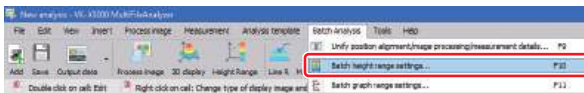
# Batch Height Range Settings

This function can apply the same height display settings to multiple measurement data, or apply settings to multiple files at once.

## Using Batch Height Range Settings

This sets the height image display for multiple measurement data at a time. Height image settings set for arbitrary measurement data can be applied to other measurement data.

### 1 Select [Batch height range settings] from the [Batch Analysis] menu.

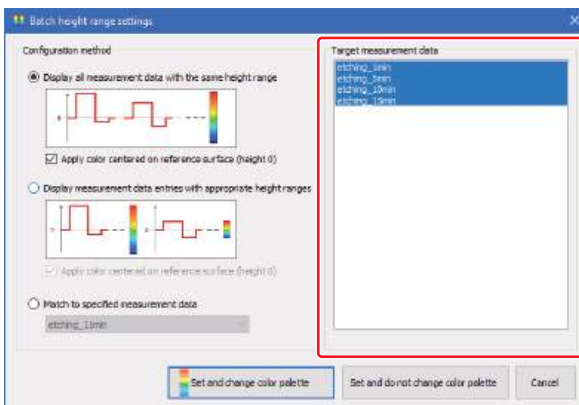


The [Batch height range settings] dialog box appears.

**Reference** You can also open the [Batch height range settings] dialog box as follows:

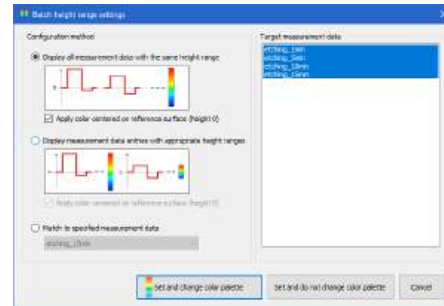
- Click the [Batch Analysis] button in "Analyze a batch of data at once" on the toolbar and on the right side of the screen, and select [Batch height range settings].
- Right-click the main image or reference image to select.

### 2 Click the target measurement data to select.



**Point** Click while pressing Ctrl or Shift to select multiple data.

### 3 Click any of the radio buttons for the configuration method.



#### [Display all measurement data with the same height range] radio button

Sets the maximum value for upper limit value and lower limit value from the entire measurement data.

#### [Apply color centered on reference surface (height 0)] checkbox

Selecting this box centers the height range color map on the reference plane. The upper and lower limits are therefore set by the greater value of either the maximum or minimum value of the measurement data.

#### [Display measurement data entries with appropriate height ranges] radio button

Automatically sets the upper limit value and lower limit value based on the maximum value and minimum value for each measurement data.

#### [Apply color centered on reference surface (height 0)] checkbox

Selecting this box centers the height range color map on the reference plane. The upper and lower limits are therefore set by the greater value of either the maximum or minimum value of the measurement data.

#### [Match to specified measurement data] radio button

Sets using the height display settings of the specified measurement data.

#### [Target measurement data] box

Specify the measurement data as a setting source. By default, the selected measurement data name is displayed.

### 4 Click the [Set and change color palette] button or [Set and do not change color palette] button.

#### [Set and change color palette] button

The color palette setting window appears.

Select the color palette to change, and click the [OK] button.

The height range color palette can be changed before applying the settings.

#### [Set and do not change color palette] button

The settings are applied on the grid sheet.

# Batch Graph Range Settings

This sets the graph display settings for multiple measurement data.

## Using Batch Graph Range Settings

This sets the graph display for multiple measurement data at a time. Graph display settings set for arbitrary measurement data can be applied to other measurement data.

- 1 Select the grid sheet on which the profile graph is displayed.
- 2 Click the cell of profile graph.
- 3 Select [Batch graph range settings] from the [Batch Analysis] menu.



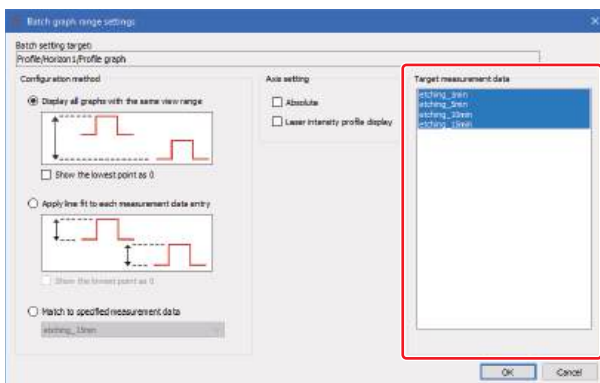
The [Batch graph range settings] dialog box appears.



You can also open the [Batch graph range settings] dialog box as follows:

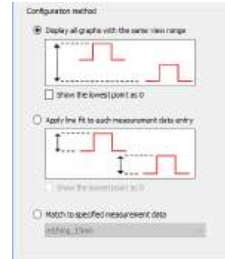
- Click the [Batch Analysis] button in "Analyze a batch of data at once" on the toolbar and on the right side of the screen, and select [Batch graph range settings].
- Select from the right-click menu of the profile graph.

- 4 Click the target measurement data to select.



Item names of the selected profile graph are displayed on [Batch setting target].

- 5 Click any of the radio buttons for the configuration method.



**[Display all graphs with the same view range] radio button**

Sets the maximum value for upper limit value and lower limit value from the entire measurement data.

**[Show the lowest point as 0] checkbox**

Selecting this box sets the axis value so that the minimum value of the entire measurement data is displayed as 0.

**[Apply line fit to each measurement data entry] radio button**

Automatically sets the graph display based on the maximum value and minimum value for each measurement data.

**[Show the lowest point as 0] checkbox**

Selecting this box sets the axis value so that the minimum value of the measurement data is displayed as 0.

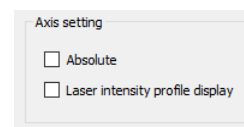
**[Match to specified measurement data] radio button**

Sets the graph display settings of the specified measurement data.

**[Target measurement data] box**

Specify the measurement data as a setting source. By default, the selected measurement data name is displayed.

- 6 Check the [Absolute] checkbox to display the profile graph 1:1



- 7 Check the [Laser intensity profile display] checkbox to display the laser intensity profile view in the profile graph.

- 8 Click the [OK] button.

The profile graph to which the set contents are applied is displayed on the grid sheet.

# Unify position alignment/image processing/measurement details

This function can apply the position alignment, image processing or measurement details to multiple measurement data, or apply settings to multiple files at once.

## Unifying position alignment/image processing/measurement details

This sets the position alignment, image processing and measurement details for multiple measurement data at a time. Settings for arbitrary measurement data can be applied to other measurement data.

### 1 Select [Unify position alignment/image processing/measurement details] from the [Batch Analysis] menu.



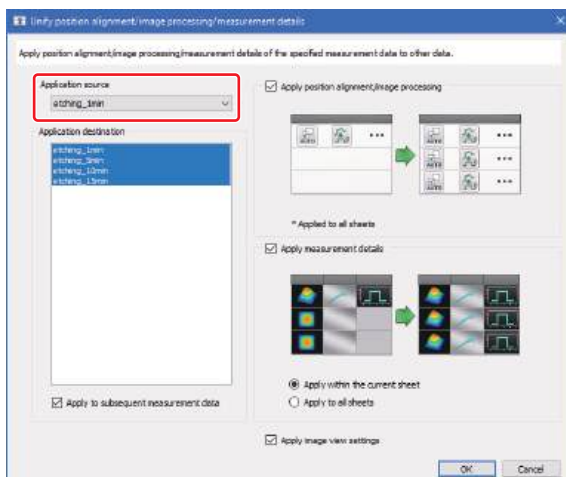
The [Unify position alignment/image processing/measurement details] dialog box is displayed.

**Reference** You can also open the [Unify position alignment/image processing/measurement details] dialog box as follows:

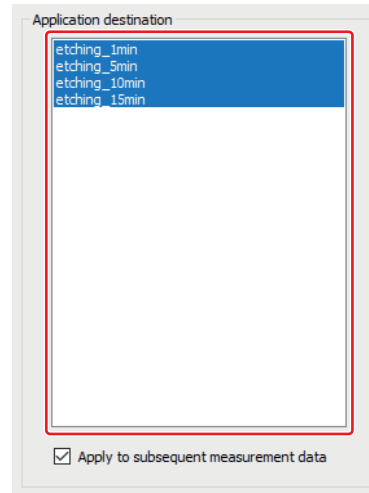
- Click the [Batch Analysis] button in "Analyze a batch of data at once" on the toolbar and on the right side of the screen, and select [Unify position alignment/image processing/measurement details].
- Select from the right-click menu of the cell.

### 2 Specify the measurement data as a setting source in the [Application source] box.

By default, the selected measurement data name is displayed.



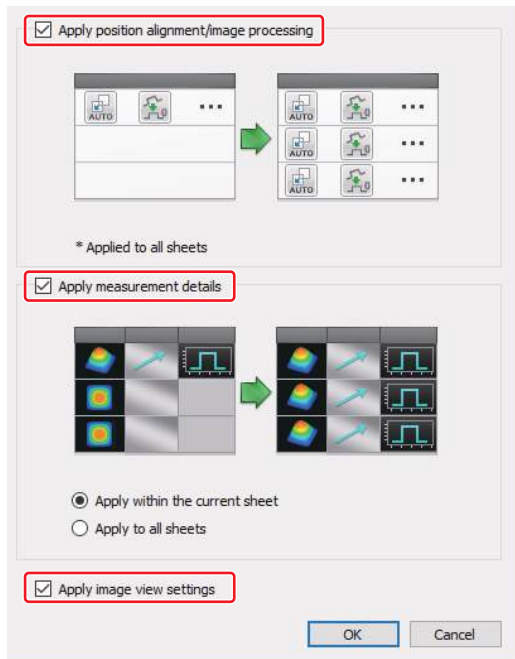
### 3 Click the measurement data under [Application destination] to select the files that will be analyzed.



Selecting [Apply to subsequent measurement data] checkbox applies the same settings when another measurement data is added.

**Point** Click while pressing Ctrl or Shift to select multiple data.

#### 4 Select the checkbox of the processing to apply.



##### **[Apply position alignment/image processing] checkbox**

Selecting this checkbox applies the position alignment and the image processing.

##### **[Apply measurement details] checkbox**

Selecting this checkbox applies the measurement details.

##### **[Apply within the current sheet] radio button**

Applies measurement contents to the measurement of the selected grid sheet.

##### **[Apply to all sheets] radio button**

Applies measurement contents to all the measurement sheets.

##### **[Apply image view settings] check box**

Select to unify the image view settings (laser + color, laser, height).

#### 5 Click the [OK] button.

Image processing and measurements are performed with the set contents.

## MEMO

# Appendix

This appendix describes the area settings, types of measurement lines, how to draw measurement lines, other functions on the main menu, and how to reinstall/uninstall Multifile Analyzer Software.

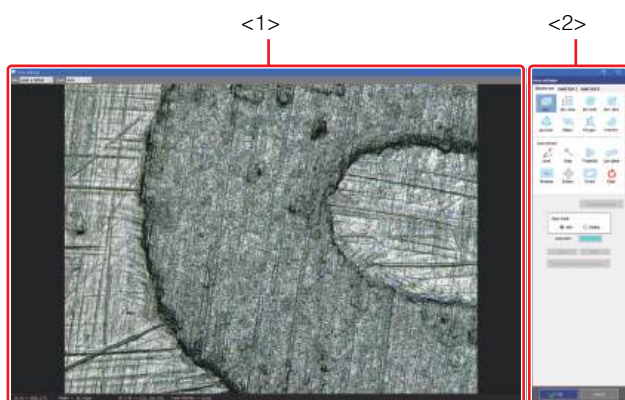
Area Settings .....	Page A-2
Types of Measurement Lines and How to Draw ....	Page A-22
Exporting Measurement Result .....	Page A-64
Other Operations .....	Page A-65
Switching the Display Language .....	Page A-68
Management Function of the Multifile Analyzer Software .....	Page A-69
Installation/Uninstallation .....	Page A-70

# Area Settings

Area settings allow for target areas to be set during image processing or measurement functions. For details about how the specified areas are used, refer to the explanation for each function.

**Reference** If the [Missing data removal] button is not selected the missing data will be removed automatically when the area is set.

## Screen Used for Area Settings



When you click the [Area settings] button in the windows for the image processing function or measurement function that uses area settings, the [Area settings] window appears.

The following describes the name and functions of each part of the [Area settings] window.

### <1> Image display area

Displays an image of the sample when you see it from the perpendicular direction to the reference plane. Set areas on this image.

### <2> Area setting tool

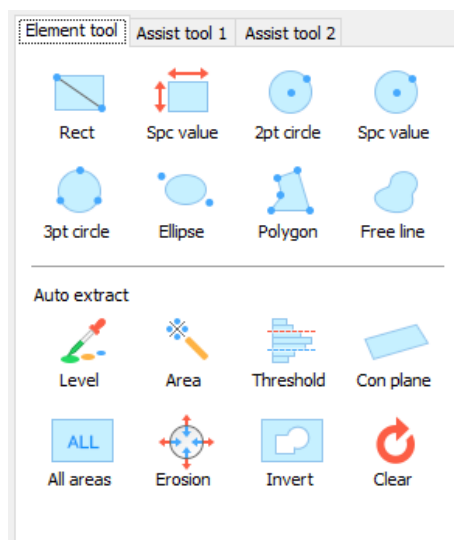
Contains buttons to set an area and tools to operate an area.

## Area Settings Tool

### ■ Element tool button

The following describes the functions of each area setting button.

For more information about how to set areas using the area setting buttons for figure drawing, refer to [Types and setting of area setting buttons \(Page A-4\)](#).



A rectangle with a diagonal that connects two points you clicked arbitrarily is set as an area.



A rectangle with a specified size is set as an area.



A circle that is defined with two points you clicked arbitrarily is set as an area.



A circle with the specified size is set as an area.



A circle that contains three points you clicked arbitrarily is set as an area.



An oval that is defined with two points you clicked arbitrarily is set as an area.



A polygon that has points you clicked arbitrarily as its corners is set as an area.



An area that is defined with a free line is set as an area.



Selects data across the entire sample that falls within the tolerance range.  
 [Book icon] [Setting an Area by Extracting a Level \(Page A-8\)](#)



Selects data across adjacent pixels that falls within the tolerance range.  
 [Book icon] [Setting an Area by Extracting an Area \(Page A-11\)](#)



A range obtained by extracting pixels that fall within the threshold from the entire image is set as an area.  
 [Book icon] [Setting an Area with Threshold \(Page A-13\)](#)



Continuous planes will be selected based on "the relative tilt component of the height data in relation to surrounded sampled pixels".  
 [Book icon] [Setting an Area with Continuous Tilt \(Page A-15\)](#)



Sets the entire image as an area.



The area near the border of the specified area can be added to or removed from the specified area.



Inverts an area you have set.  
 [Book icon] [Inverting an area \(Page A-18\)](#)



Clears all the area you have set.  
 [Book icon] [Clearing an area \(Page A-20\)](#)

### ■ Assist tool buttons

Assist tool buttons for area settings are the same as those of profile tool.

For details, please check the assist tool buttons for profile tool.

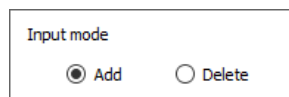
[Book icon] [\[Assist tool\] tab \(Page A-31\)](#)

[Book icon] [How to use the assist tool \(Page A-33\)](#)

### ■ Input mode

This section describes the input modes.

For how to set an area in each input mode, refer to  
 [Book icon] [Changing the Input Mode for Areas \(Page A-17\)](#).



#### [Add] radio button

Adds an area specified using the area setting button to existing areas.

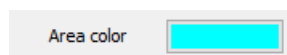
#### [Delete] radio button

Removes an area you specified using the area setting button from the areas that you have already set.

### ■ Area color

#### [Area color] option button

With the color palette, you can change the rendering color for areas you set.



### ■ Other operation buttons

**Missing data removal** Removes areas of missing data from the area you have set.

- Reference**
- The [Missing data removal] button displays when setting the area in the surface roughness measurement and volume/area measurement.
  - If the [Missing data removal] button does not display, the missing points are automatically eliminated.

**Previously set area** Display the area previously set again.

**Undo** Undoes the last step of area setting operation.  
 [Book icon] [Undoing/Redoing an Area Setting Operation \(Page A-21\)](#)

**Redo** Redoes the step that was undone.  
 [Book icon] [Undoing/Redoing an Area Setting Operation \(Page A-21\)](#)

**Display the area failed to restore**  
 Confirms the area failed to restore.  
 [Book icon] [Displaying the Area Failed to Restore \(Page A-21\)](#)

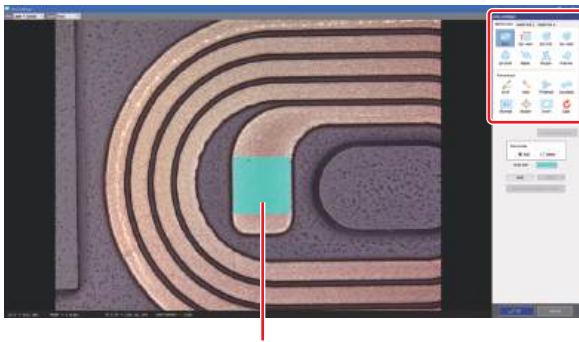
## Setting an Area by Drawing a Figure

Set an area that you draw manually by using the area setting tools.

The area can also be set by utilizing elements created with the assist tools.

**1 Click the [Area settings] button in the tool area.**  
The [Area settings] window appears.

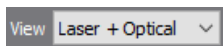
**2 Click an area setting button for figure drawing and set an area on the image.**



The area is painted in the area color.

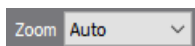
### ● Changing the display image

You can change the type of the measurement data using the [View] box.



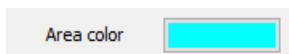
### ● Changing the display magnification

You can change the display magnification of the image from the list of the [Zoom] box.



### ● Setting the area preview color

You can change the rendering color for areas you set using the [Area display] color palette.



Click the color palette and select a new color.



### ● Changing the input mode

You can switch the input mode using the [Input mode] radio buttons.

Changing the Input Mode for Areas (Page A-17)

**3 Click the [OK] button.**

The [Area settings] window is closed and the area settings are applied.

## Types and setting of area setting buttons

### ■ [All areas] button



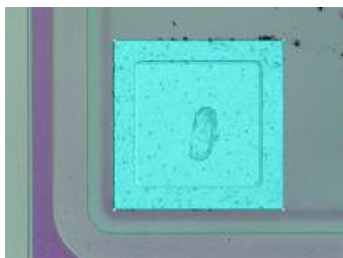
Sets the entire area of the image as an area.



### ■ [Rect] button



Set a rectangular area with a diagonal that connects the first and second points.



**1** Click the [Rect] button.

**2** Click the mouse at the first point of the rectangle, and move the mouse.

When you move the mouse, a rectangle with a diagonal that connects the first point and the position of the mouse appears.

**3** Click the mouse at the second point of the rectangle.

The rectangle specified with the range is set as an area.

### ■ [Spc value] (rectangle) button

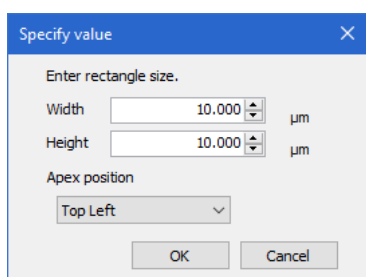


Set an area by entering numerical values for the vertical and horizontal sizes of a rectangle.

**1** Click the [Spc value] button.

The [Specify value] dialog box appears.

**2** Enter values for the size of the rectangle in [Width] and [Height] boxes, and determine the apex position in the [Apex position] box.




**3** Click the [OK] button.

**4** Click on the image.

The rectangle with the size specified in [Width] and [Height] appears, where the point you clicked is used as the apex.

**5** Drag the mouse pointer, confirm the position of the rectangle, and click the mouse.

The position of the rectangle is determined and the area is set.

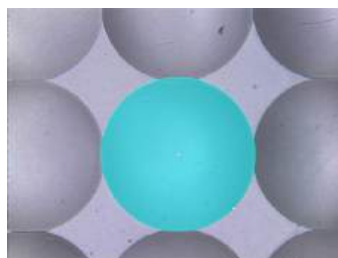
 The apex can be placed on the point element created with the assist tool.

To move the area once set, drag it to the new position.

### ■ [2pt circle] button



Set a circular area by specifying the center of a circle (the first point) and a point on the circumference of the circle (the second point).



**1** Click the [2pt circle] button.

**2** Click a circle center and move the mouse pointer.

The first clicked point is the center of the circle and the mouse's last position serves as a radial position of the circle.

**3** Click the 2nd point on the circle's circumference.

The circle with the radius in length that connects the first point and second point is set as an area.

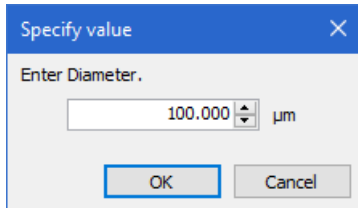
■ [Spc value] (circle) button



Set a circular area by specifying the circle center and its area.

**1** Click the [Spc value] (circle) button.

The [Specify value] dialog box appears.



**2** After entering the diameter, click the [OK] button.

**3** Click on the image.

The circle with the specified size appears, where the point you clicked is used as the center point.

**4** Drag the mouse pointer, confirm the position of the circle, and click the mouse.

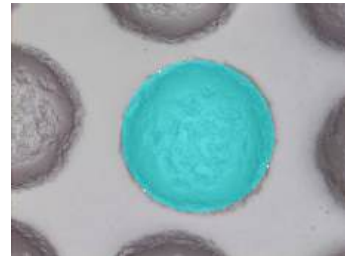
The position of the circle is determined and the area is set.

To move the area once set, drag it to the new position.

■ [3pt circle] button



Set a circular area by specifying three points on the circumference of a circle.



**1** Click the [3pt circle] button.

**2** Click the 1st point on the circle's circumference.

A cross-shaped point appears.

**3** Click the 2nd point on the circle's circumference, and move the mouse pointer.

The second point appears. When you move the mouse pointer, a circle is enlarged/reduced accordingly.

**4** Click the 3rd point on the circle's circumference.

The circle that passes through the three points is set as an area.

## ■ [Ellipse] button



Set an elliptical area inscribed in a rectangle.



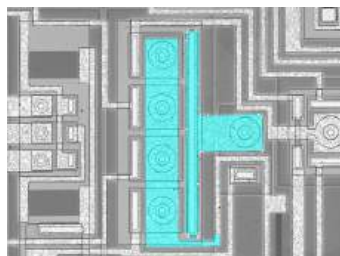
- 1** Click the [Ellipse] button.
- 2** Click the mouse at the position that should be a corner of a rectangle that an ellipse is inscribed in, and move the mouse pointer.  
When you move the mouse pointer, an ellipse is displayed.
- 3** Adjust the length of the major and minor axes of the ellipse, and click the mouse when the desired ellipse appears.

The ellipse specified with the range is set as an area.

## ■ [Polygon] button



Set a polygonal area.



- 1** Click the [Polygon] button.
- 2** Click the mouse at the start point of the polygon, and move the mouse pointer.  
When you move the mouse pointer, the line segment appears.
- 3** Click the mouse at the position that should be the second point of the polygon, and move the mouse pointer.  
When you click the mouse at the second point, a straight line is determined.
- 4** Repeat step 3, and double-click the mouse at the position that should be the end point of the figure.  
Every time you click the mouse at a point, another straight segment of a continuous line appears. When you double-click the mouse at the end point, the polygon is set as the range.  
The polygon specified with the range is set as an area.

■ [Free line] button



Set a free-shaped area.



- 1 Click the [Free line] button.
- 2 Place the mouse pointer at the start point of a line and drag it to create a figure.
- 3 Double-click the mouse at the position that should be the end point of the figure.

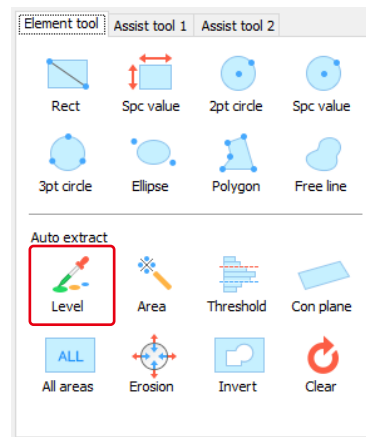
The figure is closed and an area is set.

## Setting an Area by Extracting a Level

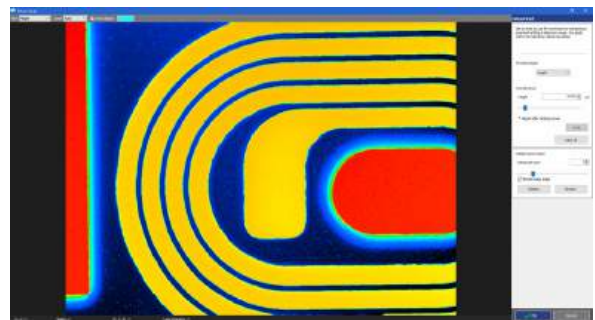
While using a value (sum of RGB or height) of the pixel sampled from the image as the reference, an area is set by extracting pixels from the entire image that falls between the reference value and specified value (tolerance),

**Reference** This function extracts data that falls within the tolerance range as an area, using the sampled pixel as the reference. Therefore, it is useful when setting an area using the same extraction conditions for data that has different measurement conditions.

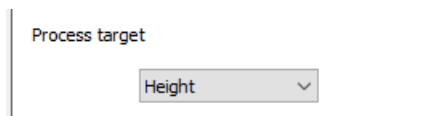
- 1 Click the [Area settings] button in the tool area. The [Area settings] window appears.
- 2 Click the [Level] button.



The [Extract level] window appears.



**3** Selects a process target for tolerance in the [Process target] box.



**4** Click on the image to sample the value of the pixel that you use as the reference value for the tolerance range.

Pixels in the entire image that fall within the tolerance range are set as an area and painted in the color specified in [Area display].

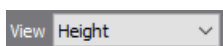
**5** Set the tolerance in [Set tolerance].

[Set tolerance] differs depending on the setting value in [Process target].

For how to set the tolerance, refer to Setting a tolerance (Page A-10).

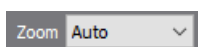
**● Changing the display image**

You can change the type of the measurement data using the [View] box.



**● Changing the display magnification**

You can change the display magnification of the image from the list of the [Zoom] box.



**● Setting the area rendering color**

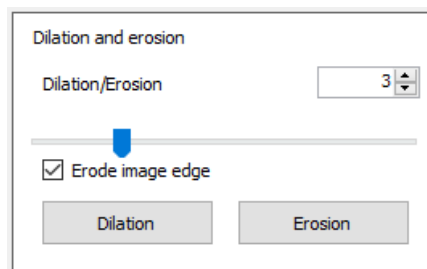
You can change the rendering color for areas you set using the [Area display] color palette.



Click the color palette and select a new color.



**● Area inflation/deflation**



Enter an inflation/deflation degree in the [Dilation/Erosion] box, and click the [Dilation]/[Erosion] button to change the value.

**6** Click the [OK] button.

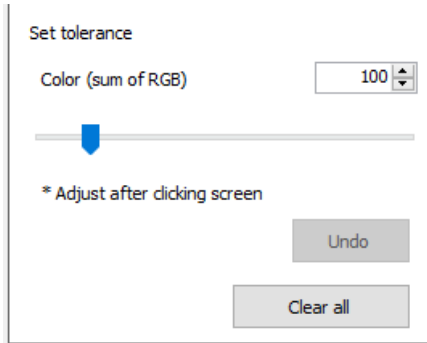
The [Extract level] window is closed, and the area is applied in the [Area settings] window.

**7** Click the [OK] button.

The [Area settings] window is closed and the area is set.

## Setting a tolerance

### ■ When the process target is [Laser+Optical] or [Optical]

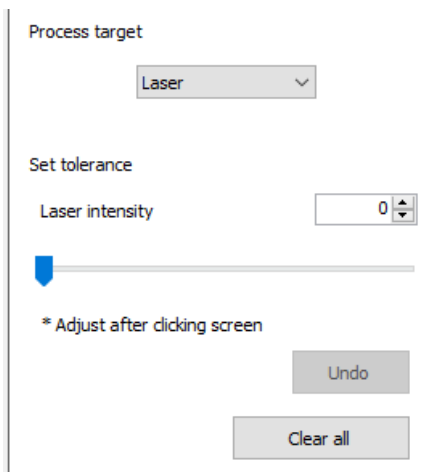


Enter the tolerance (sum of RGB) of the color to be extracted. The entered value is used as the tolerance range, using the RGB data of the pixel sampled from the image as the reference.

For example, if the value of the pixel is 100 and the tolerance is 50, then the tolerance range is  $100 \pm 50$ .

Input range: 0 to 765

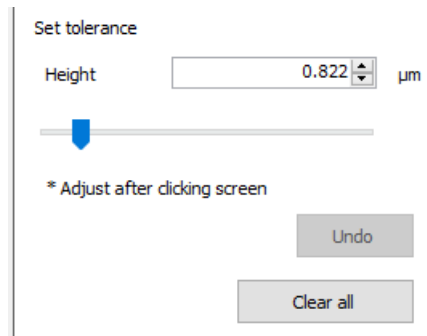
### ■ When the process target is [Laser] or [Laser intens]



Enter the tolerance of the laser intensity to be extracted. The entered value is used as the tolerance range, using the laser intensity data of the pixel sampled from the image as the reference.

Input range: 0 to 65535

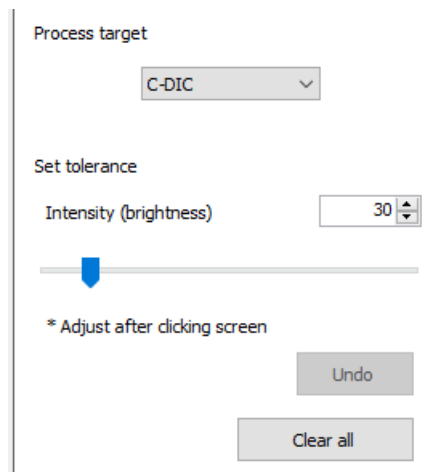
### ■ When the process target is [Height]



Enter the tolerance of the height to be extracted. The entered value is used as the tolerance range, using the height of the pixel sampled from the image as the reference.

Input range: 0 to the maximum value of the height data

### ■ When the process target is [C-DIC]



Enter the tolerance of the intensity to be extracted. The entered value is used as the tolerance range, using the intensity data of the pixel sampled from the image as the reference.

Input range: 0 to 255



- To set the tolerance from the beginning, click the [Undo] button.
- To start over the tolerance setting from the beginning, click the [Clear all] button.

## Setting an Area by Extracting an Area

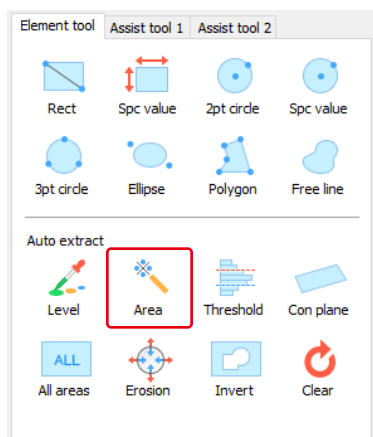
While using a value (sum of RGB or height) of the pixel sampled from the image as the reference, an area is set by only extracting pixels that fall within the tolerance range from a reference value to a specified value and are adjacent to the sampled pixel.

**Reference** This function extracts data that falls within the tolerance range as an area, using the sampled pixel as the reference. Therefore, it is useful when setting an area using the same extraction conditions for data that has different measurement conditions.

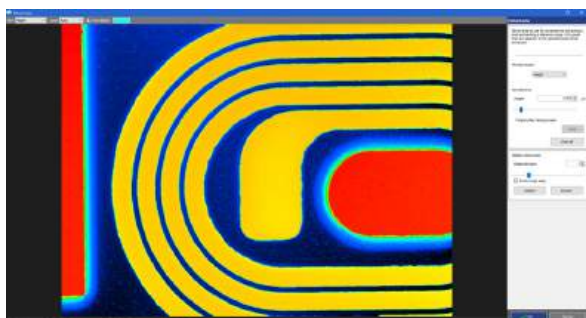
### 1 Click the [Area settings] button in the tool area.

The [Area settings] window appears.

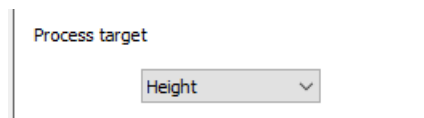
### 2 Click the [Area] button.



The [Extract area] window appears.



### 3 Selects a process target for tolerance in the [Process target] box.



### 4 Click on the image to sample the value of the pixel that you use as the reference value for the tolerance range.

Pixels in the entire image that fall within the tolerance range are set as an area and painted in the color specified in [Area display].

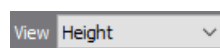
### 5 Set the tolerance in [Set tolerance].

[Set tolerance] differs depending on the setting value in [Process target].

For how to set the tolerance, refer to [Setting a tolerance \(Page A-10\)](#).

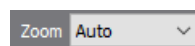
#### ● Changing the display image

You can change the type of the measurement data using the [View] box.



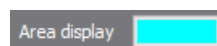
#### ● Changing the display magnification

You can change the display magnification of the image from the list of the [Zoom] box.



#### ● Setting the area rendering color

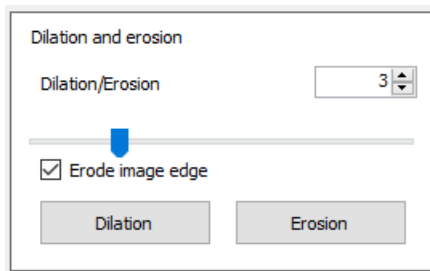
You can change the rendering color for areas you set using the [Area display] color palette.



Click the color palette and select a new color.



● **Area inflation/deflation**



Enter an inflation/deflation degree in the [Dilation/Erosion] box, and click the [Dilation]/[Erosion] button to change the value.

**6** Click the [OK] button.

The [Extract area] window is closed, and the area is applied in the [Area settings] window.

**7** Click the [OK] button.

The [Area settings] window is closed and the area is set.

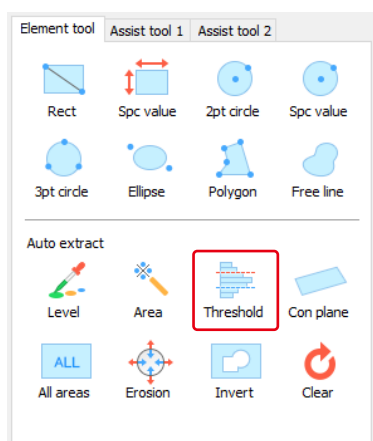
## Setting an Area with Threshold

Set an area by setting two threshold values (upper and lower limits) and extracting pixels that fall between the values from the entire image.

**Reference** This function sets an area by setting an extraction level for a value of the original data. Therefore, it is useful when setting an area using the same extraction conditions for multiple pieces of data that have the same measurement conditions.

**1** Click the **[Area settings]** button in the tool area.  
The **[Area settings]** window appears.

**2** Click the **[Threshold]** button.



The **[Threshold]** dialog box appears.

**3** Enter the tolerance in the **[Threshold]** dialog box, and click the **[OK]** button.

The **[Threshold]** dialog box changes depending on the type of the display image.

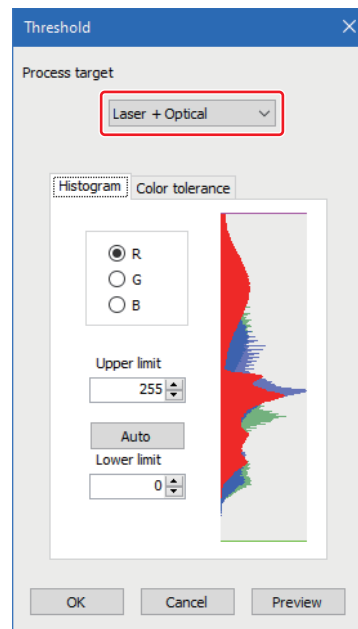
For how to set the threshold, refer to Setting threshold values (Page A-13).

**4** Click the **[OK]** button in the **[Area settings]** window.

The **[Area settings]** window is closed and the area is set.

## Setting threshold values

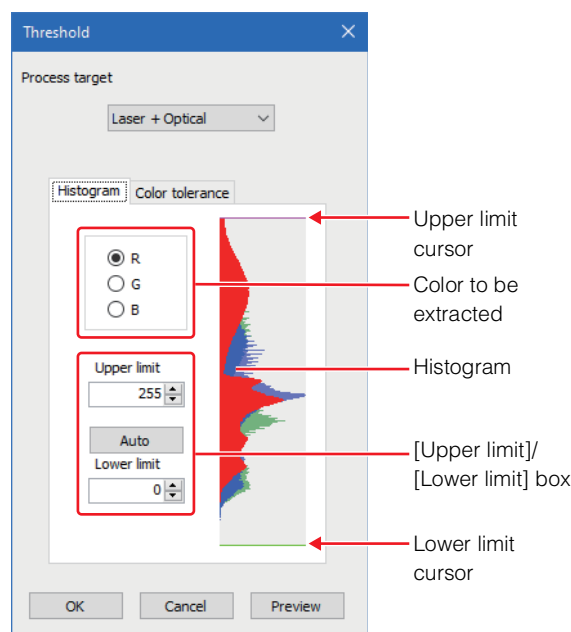
**1** Select a type for the process target image from the **[Process target]** pull-down list.



■ When **[Laser+Optical]** or **[Optical]** is selected

Set the color tolerance in the **[Histogram]** or **[Color tolerance]** tab.

● **[Histogram]** tab



- 2 Turn on the color to be extracted (the [R], [G], or [B] option button).
- 3 Enter the upper and lower threshold values in the [Upper limit] and [Lower limit] boxes, or drag the upper limit and lower limit cursors in the histogram.

Pixels that have the color to be extracted and fall within the threshold values are extracted from the entire image and set as an area.

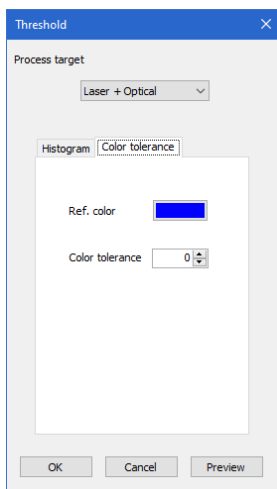
**Auto-setting of threshold values**

Click the [Auto] button to automatically set the threshold.

**Previewing the area**

Click the [Preview] button to preview the area you set.

● [Color tolerance] tab



- 2 Click the [Ref. color] color palette to open the [Color] dialog box and set the reference color to be extracted.
- 3 Enter the tolerance (sum of RGB) of the color to be extracted in the [Color tolerance] box.

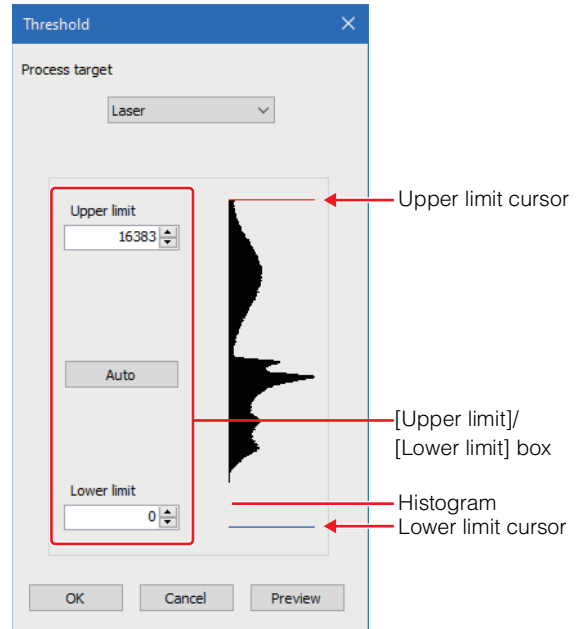
Using the reference color as the reference, pixels that fall within the specified color tolerance range (between the positive and negative values) are extracted from the entire image, and set as an area.

**Previewing the area**

Click the [Preview] button to preview the area you set.

■ When [Laser] or [Laser intens] is selected

- 2 Set the threshold using the histogram.



Enter the upper and lower threshold values in the [Upper limit] and [Lower limit] boxes, or drag the upper limit and lower limit cursors in the histogram.

**Auto-setting of threshold values**

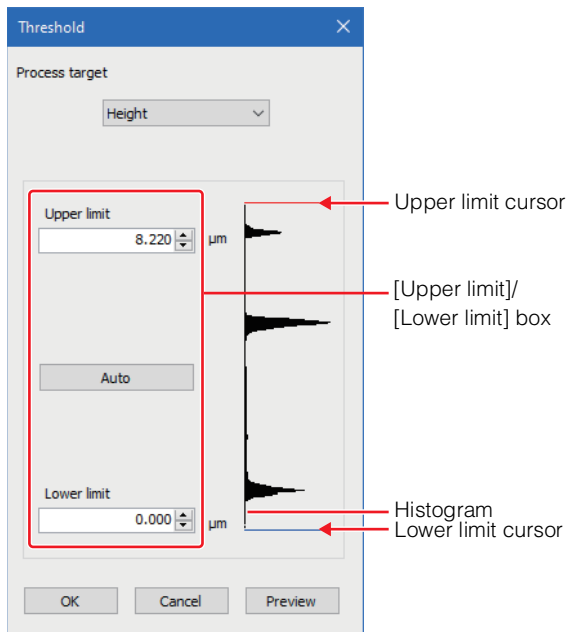
Click the [Auto] button to automatically set the threshold.

**Previewing the area**

Click the [Preview] button to preview the area you set.

■ When [Height] is selected

2 Set the threshold using the histogram.



Enter the upper and lower threshold values in the [Upper limit] and [Lower limit] boxes, or drag the upper limit and lower limit cursors in the histogram.

**Auto-setting of threshold values**

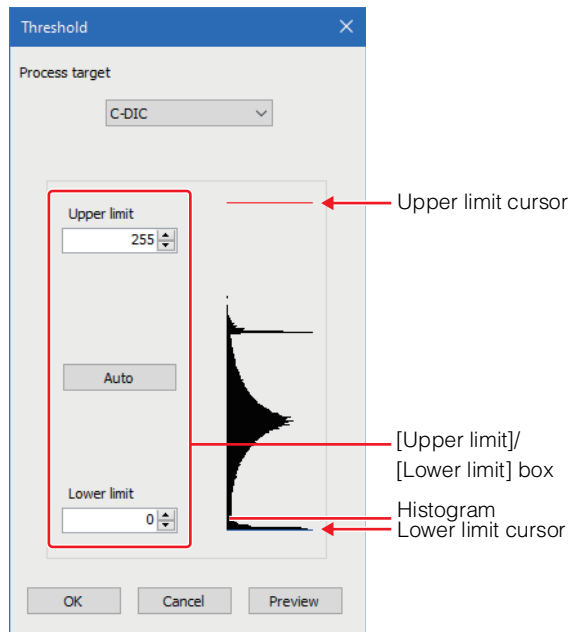
Click the [Auto] button to automatically set the threshold.

**Previewing the area**

Click the [Preview] button to preview the area you set.

■ When [C-DIC] is selected

2 Set the threshold using the histogram.



Enter the upper and lower threshold values in the [Upper limit] and [Lower limit] boxes, or drag the upper limit and lower limit cursors in the histogram.

**Auto-setting of threshold values**

Click the [Auto] button to automatically set the threshold.

**Previewing the area**

Click the [Preview] button to preview the area you set.

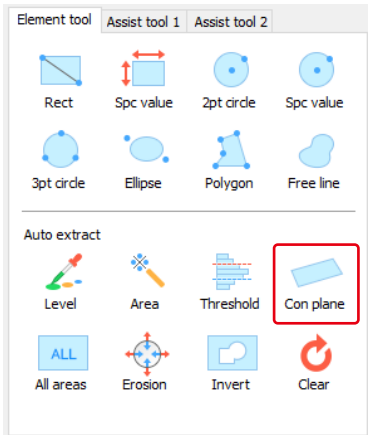
**Setting an Area with Continuous Tilt**

Continuous planes will be selected based on the relative tilt component of the height data in relation to surrounded sampled pixels.

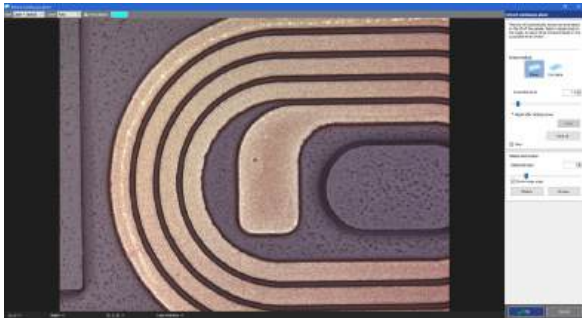
1 Click the [Area settings] button in the tool area.

The [Area settings] window appears.

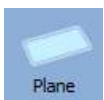
**2 Click the [Con plane] button.**



The [Extract continuous plane] window appears.



**3 Set how to extract an area in [Extract method].**



Extracts a flat plane.

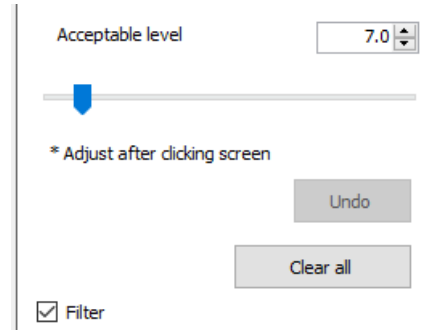


Extracts the continuous plane smoothly.

**4 Click on the image to sample the value of the pixel that used as reference value.**

The area is specified and then painted in the [Area display].

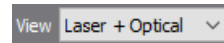
**5 Specify an acceptable value set for the area in [Acceptable level].**



Select the [Filter] check box to remove minute noise on the surface and extract continuous planes.

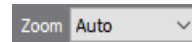
**● Changing the display image**

You can change the type of the measurement data using the [View] box.



**● Changing the display magnification**

You can change the display magnification of the image from the list of the [Zoom] box.



**● Setting the area rendering color**

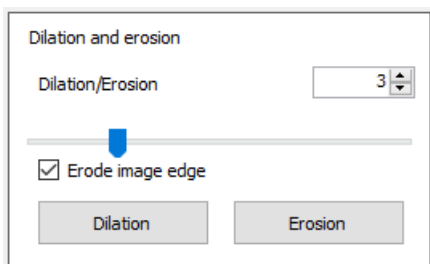
You can change the rendering color for areas you set using the [Area display] color palette.



Click the color palette and select a new color.



● Area dilation/erosion



Enter an inflation/deflation degree in the [Dilation/Erosion] box, and click the [Dilation]/[Erosion] button to change the value.

**6** Click the [OK] button.

The [Extract continuous plane] window is closed, and the area is applied in the [Area settings] window.

**7** Click the [OK] button.

The [Area settings] window is closed and the area is set.

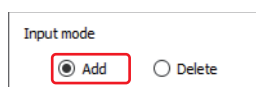
## Changing the Input Mode for Areas

You can specify how to add/delete areas with [Input mode].

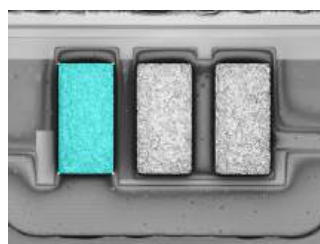
■ Adding areas sequentially

When the input mode is [Add], you can add areas sequentially on the screen.

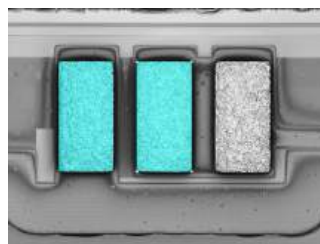
**1** Click the [Add] radio button of the input mode.



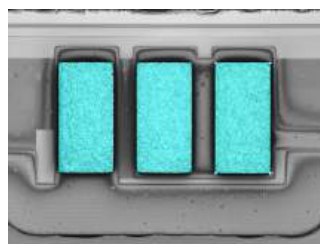
**2** Set the first area.



**3** Set the second area.



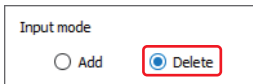
**4** Add additional areas as needed.



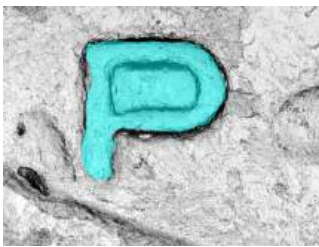
### ■ Deleting a specified part of an area

In the [Delete] input mode, when you specify a range on an area that have already been set, the specified part of the area is deleted.

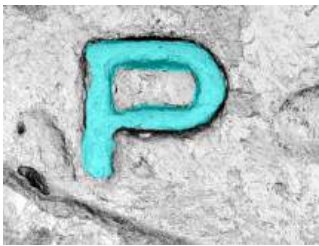
#### 1 Click the [Delete] radio button of the input mode.



#### 2 Specify a range of the part to delete on the set area.



The part you specified with the range is deleted from the set area.



### Inverting an area

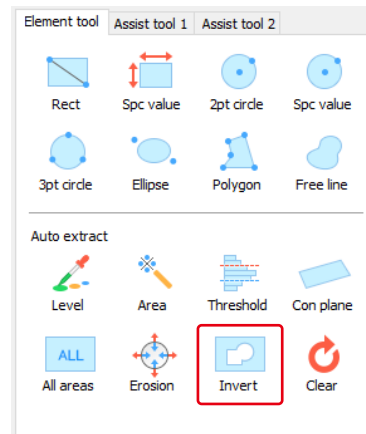
Inverts an area you have set.

#### 1 Set an area in the [Area settings] window.

- 📖 Setting an Area by Drawing a Figure (Page A-4)
- 📖 Setting an Area by Extracting a Level (Page A-8)
- 📖 Setting an Area by Extracting an Area (Page A-11)
- 📖 Setting an Area with Continuous Tilt (Page A-15)
- 📖 Setting an Area with Threshold (Page A-13)



#### 2 Click the [Invert] button.



The area in the image display area is inverted.

**3 Click the [OK] button.**

The [Area settings] window is closed and the inverted area is set.



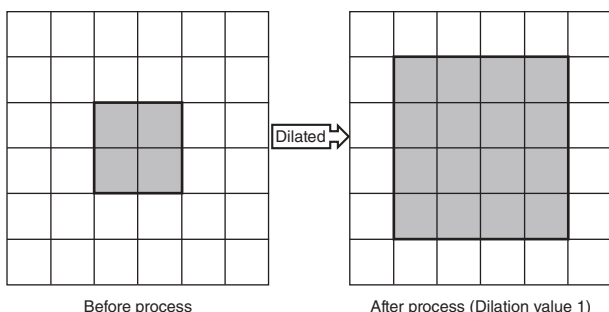
### Inflating/Deflating an area

Inverts an area you have set.

**• Area inflation**

Dilates the border of an area by the pixels set for dilation.

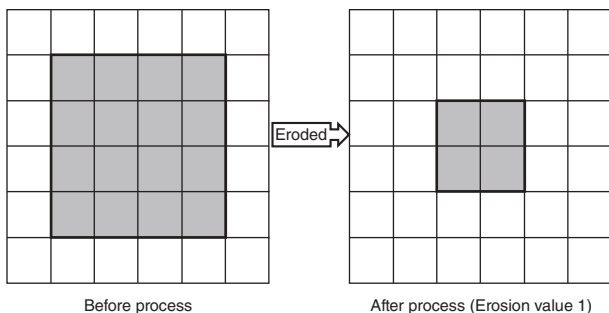
Use this for fine adjustment of the range selected first when specifying an area.



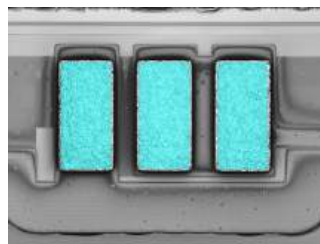
**• Area deflation**

Removes the border of an area by the pixels set for erosion, and reduces it.

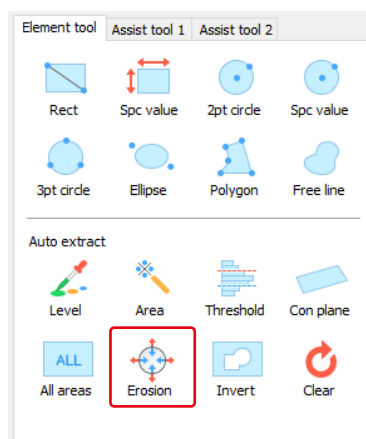
Use this for fine adjustment of the range selected first when specifying an area.



**1 Set an area in the [Area settings] window.**

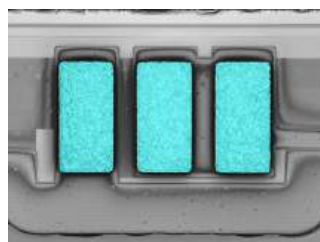
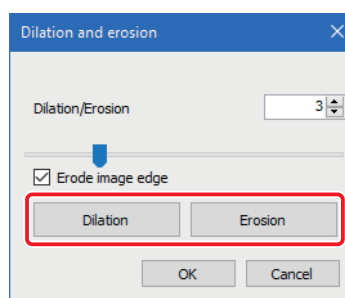


**2 Click the [Erosion] button.**



The [Dilation and erosion] window appears.

**3 Enter an inflation/deflation degree in the [Dilation/ Erosion] box, and click the [Dilation]/[Erosion] button.**

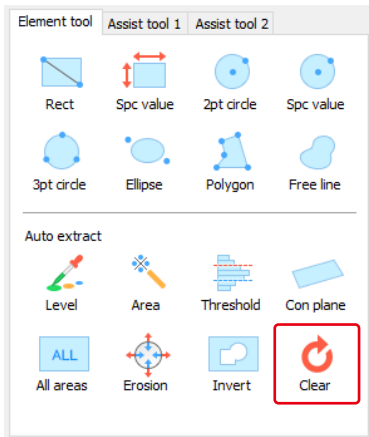


**4 Click the [OK] button.**

## Clearing an area

Clears an area you have set.

### 1 Click the [Clear] button.



The area in the image display area is cleared.

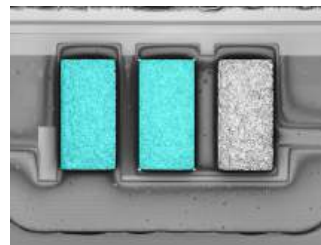


## Returning to Previous Settings of the Area being Edited

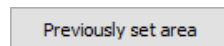
The area being edited returns to the state when the [Area settings] window is displayed.

### 1 Edit an area in the [Area settings] window.

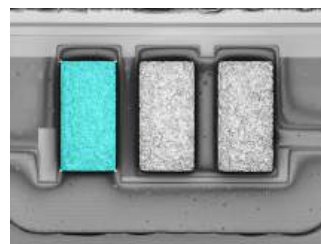
- 📖 Setting an Area by Drawing a Figure (Page A-4)
- 📖 Setting an Area by Extracting a Level (Page A-8)
- 📖 Setting an Area by Extracting an Area (Page A-11)
- 📖 Setting an Area with Continuous Tilt (Page A-15)
- 📖 Setting an Area with Threshold (Page A-13)



### 2 Click the [Previously set area] button.




The edited area returns to the state when the [Area settings] window is displayed.








## Undoing/Redoing an Area Setting Operation

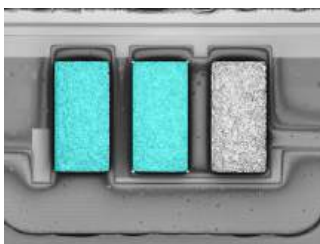
### Undoing an area setting operation

Retracts the last step of area setting operation.

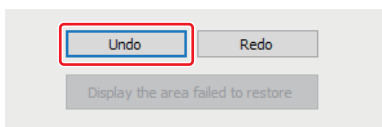
 You can undo up to 10 steps.

#### 1 Set an area in the [Area settings] window.

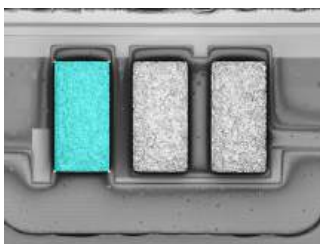
-  Setting an Area by Drawing a Figure (Page A-4)
-  Setting an Area by Extracting a Level (Page A-8)
-  Setting an Area by Extracting an Area (Page A-11)
-  Setting an Area with Continuous Tilt (Page A-15)
-  Setting an Area with Threshold (Page A-13)



#### 2 Click the [Undo] button.



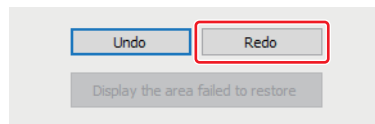
The last step of area setting operation is undone.



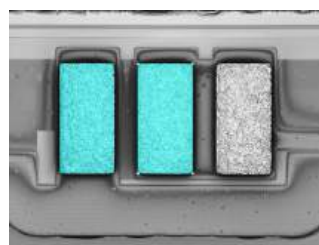
### Redoing an area setting operation

You can redo the operation you canceled using the [Undo] button.

#### 1 Click the [Redo] button after undoing an operation using the [Undo] button.



The operation you canceled with the [Undo] button is recovered.

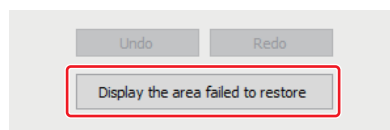


### Displaying the Area Failed to Restore

The extraction of the assist tool may fail if functions such as batch analysis is being used. If you try to select the area by reusing this point, the area extraction will fail.

You can confirm the original settings of the area failed in area extracting.

#### 1 Click the [Display the area failed to restore] button.



The [An area failed to restore] screen appears.

# Types of Measurement Lines and How to Draw

This section describes types of measurement lines used in profile measurement, line roughness measurement, plane measurement (point height) and comparative measurement, and how to draw them.

## What is an Element?

All figures placed using the profile tools or measurement tools consist of "elements".

There are two types of elements as below.

- Basic elements

Smallest blocks that make up a figure. There are 5 types of basic elements: Points, circles, and lines, as well as rectangles and tetragons which are ancillary elements to specify an area.

- Measurement elements

Elements that consist of at least one basic element. Each measurement element corresponds to each button of profile tools or measurement tools. For example, [2 Points] consists of two points and one line of basic elements.

On the drawing of each button of the profile tools or measurement tools, points of red or light blue show points of basic elements, red lines show lines of basic elements, and red circles show circles of basic elements.

### ■ Reuse of elements

Basic elements are reusable when you place a measurement element. For example, a point placed using [Assist tool] can be reused to specify a starting point or ending point of [2 Points] of [Profile line].

When you put the mouse pointer over an element you can reuse, it is highlighted. Click the highlighted element to reuse it. You can reuse the same element more than once.

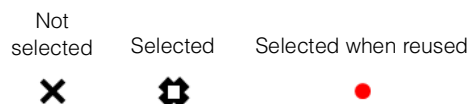


- **The elements that sit within a certain distance (adsorption distance) from the mouse pointer will be reused. If you do not want to reuse any element, click the mouse while holding the Alt key, or select [New point] from the right-click menu.**
- **When there are more than one element within the adsorption distance, the nearest element will be reused. Or by using the right-click menu, you can select an element from several elements placed within the adsorption distance (In this case, the element that you put the mouse pointer over on the menu will be highlighted on the image).**
- **Once the placement of the element or setting of the measurement line is completed, you cannot replace the reused element with another element or cancel the reuse. If it is before the completion, you can select [Back] from the right-click menu to undo the last step.**

### ■ Types and operations of elements

While an element placed on the screen is selected, when the shape of the points that define the position of the element changes to a resizing handle, you can drag a point to move the position. By doing this, you can perform an operation such as resizing a measurement element. A measurement element that does not include reused elements can be moved parallel by dragging a part other than a point. A reused element cannot be moved since a resizing handle will not appear.

#### [Examples of point element]



The following describes the details of elements and the display and operation when you select a measurement element that does not include reused elements.

### ● Point element

An element that expresses a point on the screen.

#### Display when selected

A resizing handle is displayed.

#### Operation when selected

Drag to move.

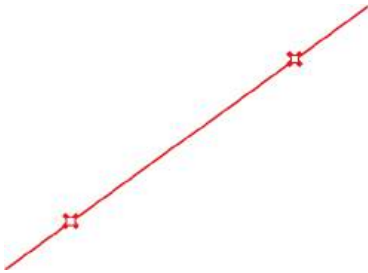
### ● Line element

There are several types as below, depending on how you specify points that define straight lines.

- A straight line defined with one point, such as vertical line and horizontal line
- A straight line defined with a reference line and one point, such as perpendicular line and parallel line
- A straight line defined with two points (or more), such as 2-point line and straight line
- A straight line obtained from stereoscopic shape data, such as intersection line of a surface and cylinder axis

#### Display when selected

The line becomes thick and the resizing handles are displayed on the points that define the straight line.



#### Operation when selected

Drag a resizing handle to move a point.

The straight line can be moved parallel by dragging a part other than a point.

### ● Circle element

An element that expresses a circle on the screen.

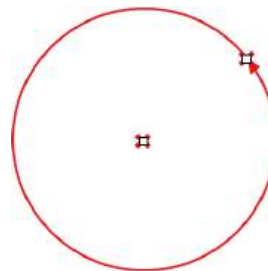
There are two types as below.

- A circle specified with points on the circumference (a circle by the assist tool)  
This type of circle is defined with three points (or more) on the circumference and has a center point obtained automatically from those points.
- A center-specified circle (a circle by the profile line tool)  
This type of circle is defined with two points of a center point and a point on the circumference.

#### Display when selected

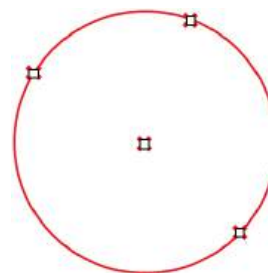
- 2-point circle

The line becomes thick and the resizing handles are displayed on the points that define the circle.



- 3-point circle

The line becomes thick and the resizing handles are displayed on the center point and the three points on the circumference that define the circle.



#### Operation when selected

- 2-point circle

Drag a resizing handle on the circumference or center point to move only the point, keeping the other point fixed.

The circle can be moved parallel by dragging other parts on the circumference.

- 3-point circle

Drag a resizing handle on the circumference to move only the point, keeping the other two points on the circumference fixed.

The circle can be moved parallel by dragging other parts on the circumference or the center point.

### ● Rectangle element

Use this to specify an area to detect an intersection line of a surface, maximum point, minimum point or stripe.

#### Display when selected

Resizing handles are displayed at four corners.



#### Operation when selected

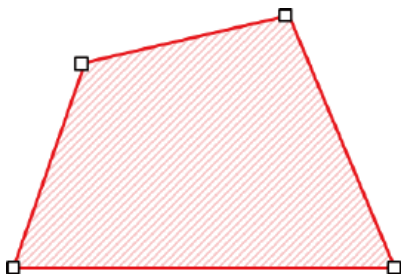
Drag one of the four corners to resize it.

### ● Tetragon element

Use this to specify an area to detect a center point of a sphere, a cone axis, or a cylinder axis. Specify this element with four points. You can also specify a shape of four sides in which two sides intersect with each other.

#### Display when selected

Resizing handles are displayed at four points.

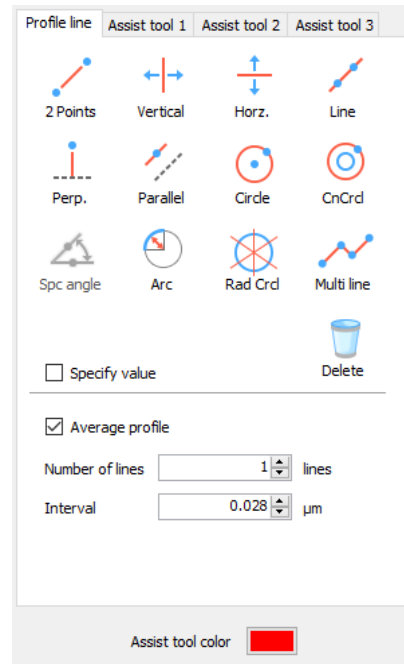


#### Operation when selected

Drag one of the four corners to change the shape.

## Profile Tool

In the profile tool, click a button of each tool to set various measurement lines. Click a tool button to select the tool. While the tool is selected, click or drag in the image display area to place an element of the tool. Once the element is placed, the tool will be deselected.



You can change the range of a measurement line by dragging a resizing handle of a element placed when the measurement line is set.

The following describes the functions of the buttons.

### [Profile line] tab

In the [Profile line] tab, you can set a measurement line to measure a shape of profile.
























Measures a line segment that connects two points specified arbitrarily as a measurement line.

☞ [2 Points] button (Page A-26)



Measures a straight line vertical to the display image as a measurement line.


☞ [Vertical] button (Page A-26)


-  Measures a straight line horizontal to the display image as a measurement line.  
 [Horz.] button (Page A-26)
-  Measures a straight line that passes through two points specified arbitrarily as a measurement line.  
 [Line] button (Page A-27)
-  Measures a straight line vertical to a reference line specified arbitrarily as a measurement line.  
 [Perp.] button (Page A-27)
-  Measures a straight line parallel to a reference line specified arbitrarily as a measurement line.  
 [Parallel] button (Page A-28)
-  Measures a circle that consists of two points specified arbitrarily as a measurement line.  
 [Circle] button (Page A-28)
-  Measures a circle with the identical center but a different radius as a measurement line.  
 [CnCrD] button (Page A-29)
-  Measures a straight line that intersects with an arbitrarily specified reference line at the specified angle as a measurement line. This item is selectable when the [Specify value] checkbox is selected.  
 [SpC angle] button (Page A-29)
-  Measures an arc that consists of three points specified arbitrarily as a measurement line.  
 [Arc] button (Page A-30)
-  Measures a radiant line that passes through the center point of the arbitrary specified circle as a measurement line.  
 [Rad Crd] button (Page A-30)
-  Measures a polygonal line that consists of the point specified arbitrarily as a measurement line.  
 [Multi line] button (Page A-31)
-  Deletes the measurement line you have created.

### ● [Specify value] checkbox

You can obtain a profile with accurate length by setting the measurement line after specifying the numeric values.

This function is effective for measuring "2 Points", "Parallel", "Circle" and "CnCrD".

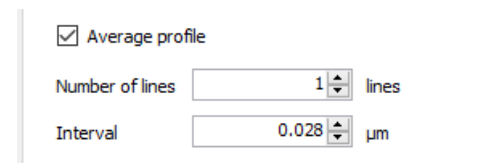
When the [Specify value] checkbox is selected,  will be displayed on the target button.

Click the  button showing, and enter a value into the [Specify value] dialog box. You can set a measurement line fixed to the specified value.

### ● [Average profile] checkbox

Specifying multiple measurement lines parallel to a measurement line allows variations in measurement areas to be eliminated and an average profile to be acquired.

Select the checkbox and set each item.




### [Number of lines] box

In addition to the specified measurement line (reference line) drawn on the image, enter the number of lines (n) to be drawn on both sides of the line. When the reference measurement line is drawn, measurement lines of specified number (n) are automatically drawn on both sides of the reference line, and the total number of measurement lines will be  $2n + 1$ .

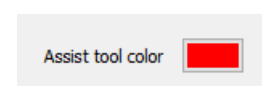
### [Interval] box

Enter the interval between measurement lines. The greater the value, the larger the interval.

 The average profile setting function is unavailable for [Circle], [CnCrD], and [Rad Crd].

### ● [Assist tool color] color palette

Click the color palette to select the color for the assist tool.



## How to use profile line tool

The following describes how to set a measurement line using the profile line tool.

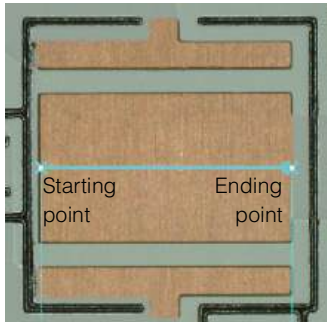
### ■ [2 Points] button



Measures a line segment that connects two points specified arbitrarily as a measurement line.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Point (both ends of the measurement line)



- 1 Click the [2 Points] button.**
- 2 Click the starting point and move the mouse pointer.**  
When you move the mouse pointer, the line segment appears.
- 3 Click a desired end point.**  
The measurement line is determined.

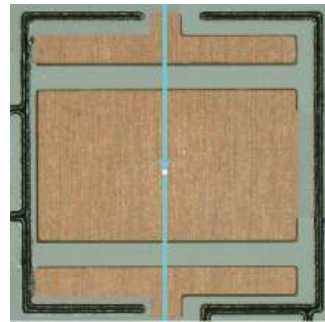
### ■ [Vertical] button



Measures a straight line vertical to the display image as a measurement line.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Straight line (vertical line)



- 1 Click the [Vertical] button.**
- 2 Click an arbitrary position.**  
The measurement line is determined.

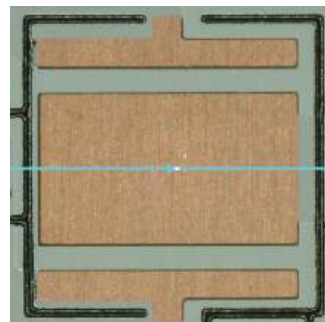
### ■ [Horz.] button



Measures a straight line horizontal to the display image as a measurement line.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Straight line (horizontal line)



- 1 Click the [Horz.] button.**
- 2 Click an arbitrary position.**  
The measurement line is determined.

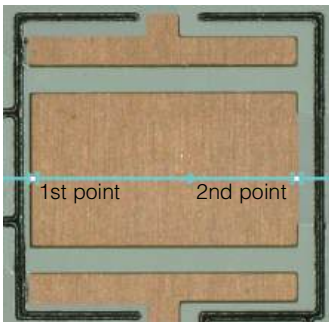
## ■ [Line] button



Measures a straight line that passes through two points specified arbitrarily as a measurement line.

Reusable element at the time of placement  
Point, Line

Reusable element after the placement  
Point, Line



- 1** Click the [Line] button.
- 2** Click the 1st point arbitrarily, and move the mouse pointer.  
When you move the mouse pointer, a straight line is displayed.
- 3** Move the mouse pointer and click an arbitrary 2nd point.  
The measurement line is determined.

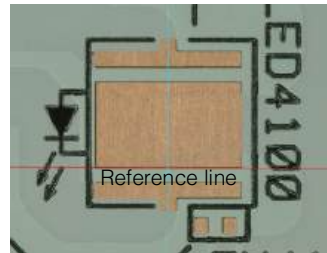
## ■ [Perp.] button



Measures a straight line vertical to a reference line specified arbitrarily as a measurement line.

Reusable element at the time of placement  
Straight line (when a reference line is specified), Point

Reusable element after the placement  
Straight line (reference line, perpline)



- 1** Click the [Perp.] button.
- 2** Put the mouse pointer over a position where you want to locate the reference line, and click the position.  
When you move the mouse pointer, the reference line is rotated 360 degrees.
- 3** Select the desired position for the reference line, then click the position.  
The reference line is determined and a line perpendicular to the reference line is displayed.
- 4** Place the mouse pointer over a position where you want to make a measurement, and click the position.  
The measurement line perpendicular to the specified reference line is determined.

## ■ [Parallel] button



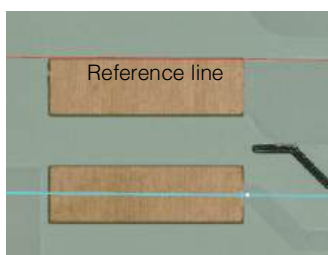
Measures a straight line parallel to a reference line specified arbitrarily as a measurement line.

Reusable element at the time of placement

Straight line (when a reference line is specified), Point

Reusable element after the placement

Straight line (reference line, parallel line)



**1** Click the [Parallel] button.

**2** Put the mouse pointer over a position where you want to locate the reference line, and click the position.

When you move the mouse pointer, the reference line is rotated 360 degrees.

**3** Select the desired position for the reference line, then click the position.

The reference line is determined and a line parallel to the reference line is displayed.

**4** Place the mouse pointer over a position where you want to make a measurement, and click the position.

The measurement line parallel to the specified reference line is determined.

## ■ [Circle] button



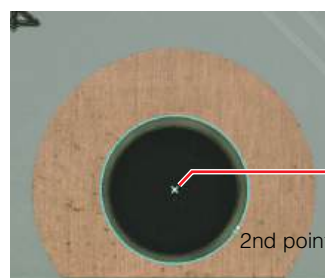
Measures a circle that consists of two points specified arbitrarily as a measurement line.

Reusable element at the time of placement

Point, Circle

Reusable element after the placement

Point (center point), Circle



**1** Click the [Circle] button.

**2** Click a circle center and move the mouse pointer.

The first clicked point is the center of the circle and the mouse's last position serves as a radial position of the circle.

**3** Move the mouse pointer and click the position where you want to make a measurement.

The circular measurement line with the radius obtained from the line connecting the two points is determined.

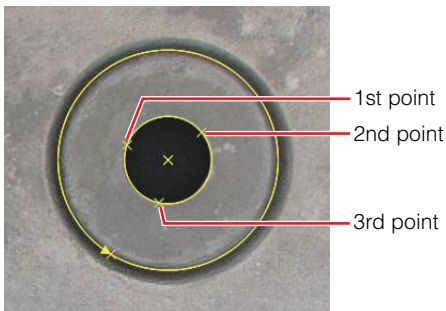
## ■ [CnCrd] button



Measures a circle with the identical center but a different radius as a measurement line.

Reusable element at the time of placement  
Point, Circle

Reusable element after the placement  
Point (center point), Circle



- 1** Click the [CnCrd] button.
- 2** Click the 1st point on the edge of the circle and move the mouse pointer.
- 3** Click the 2nd point on the circle and move the mouse pointer.  
Moving the mouse pointer enlarges or reduces the circle accordingly.
- 4** Click the 3rd point on the circle and move the mouse pointer.  
When you click the third point on the edge of the circle. The circle that passes through the specified three points is displayed. When you move the mouse pointer, the circle of which the center point is the same as the displayed circle and where the mouse pointer position is the radius is displayed.
- 5** Click the desired position where you want to make a measurement.  
The measurement line is determined.

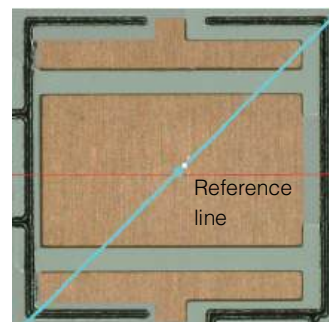
## ■ [Spc angle] button

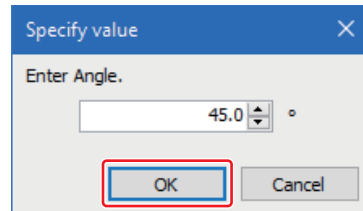


Measures a straight line that passes through a point specified arbitrarily and intersects with a reference line at a specified angle as a measurement line.

Reusable element at the time of placement  
Straight line (when a reference line is specified), Point

Reusable element after the placement  
Straight line (reference line, the line that intersects with the reference line at the specified angle)



- 1** Click the [Spc angle] button.  
The [Spc angle] dialog box appears.
- 2** Enter an angle against the reference line and click the [OK] button.  

- 3** Put the mouse pointer over a position where you want to locate the reference line, and click the position.  
When you move the mouse pointer, the reference line is rotated 360 degrees.
- 4** Select the desired position for the reference line, then click the position.  
The reference line is determined and a line that intersects with the reference line at the specified angle is displayed. When you move the mouse pointer, the measurement line is moved parallel, keeping the angle against the reference line fixed.
- 5** Click the desired position where you want to make a measurement.  
The measurement line is determined.

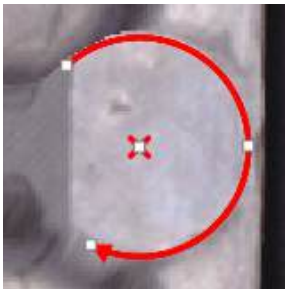
## ■ [Arc] button



Measures an arc that consists of three points specified arbitrarily as a measurement line.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Point (center point of the arc), Arc



- 1** Click the [Arc] button.
- 2** Click the first point on the edge of the circle, and move the mouse pointer.
- 3** Click the second point on the circle, and move the mouse pointer.  
When you move the mouse pointer, a circle is enlarged/reduced accordingly.
- 4** Click the third point on the circle and move the mouse pointer.  
The arc that passes through the specified three points and the center point of the circle are displayed. The arc whose radius is the position of the mouse pointer is displayed.
- 5** Click the desired position where you want to make a measurement.  
The measurement line is determined.

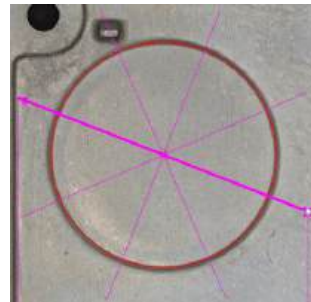
## ■ [Rad Crd] button



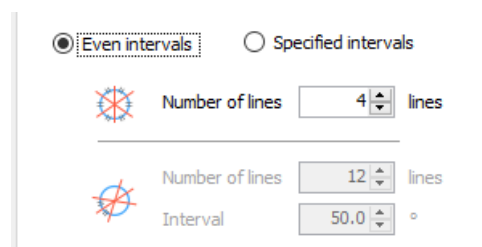
Measures a radial line through the center of the circle specified arbitrarily.

Reusable element at the time of placement  
Point, Circle, Arc

Reusable element after the placement  
Point (center point of the circle/arc), Circle, Arc



- 1** Click the [Rad Crd] button.
- 2** Click the first point on the edge of the circle, and move the mouse pointer.
- 3** Click the second point on the circle, and move the mouse pointer.  
When you move the mouse pointer, a circle is enlarged/reduced accordingly.
- 4** Click the third point on the circle and move the mouse pointer.  
The arc that passes through the specified three points and the center point of the circle are displayed. When you move the mouse pointer, the line segment that passes through the center point of the circle appears.
- 5** Click the desired position where you want to make a measurement.  
The measurement line is determined.
- 6** Specify the number of lines and interval by [Even intervals]/[Specified intervals] radio button of the profile tool as needed.



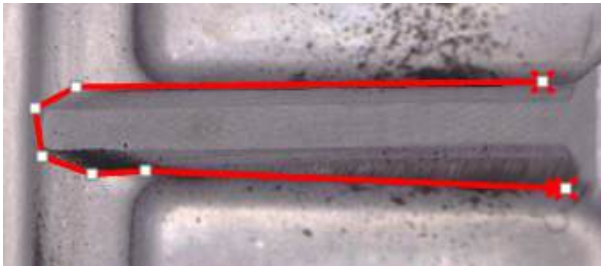
## ■ [Multi line] button



Measures a polygonal line that consists of multiple points specified arbitrarily as a measurement line.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Point (starting point, ending point)



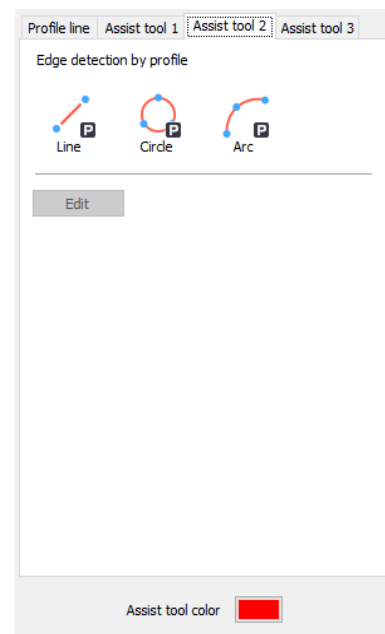
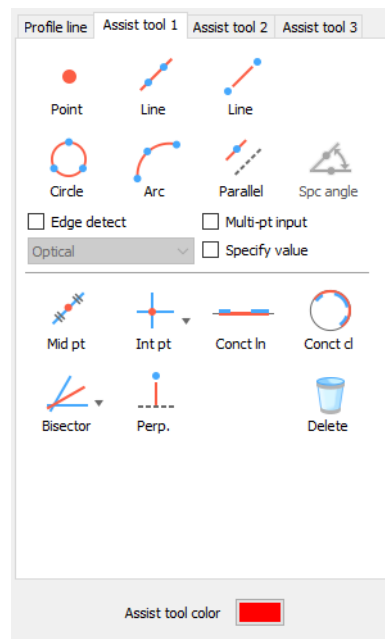
- 1** Click the [Multi line] button.
- 2** Click the starting point of the polygon line, and move the mouse pointer.  
When you move the mouse pointer, the line segment appears.
- 3** Click on the returning point of the polygon line, and move the mouse pointer.  
The line is confirmed.
- 4** Repeat step 3, and double-click the mouse at the position that should be the end point of the figure.  
Every time you click on an arbitrary place, a continuous line appears. When you double-click the mouse on the last point, the polygon line will be displayed.
- 5** Move the mouse pointer and click the position where you want to make a measurement.

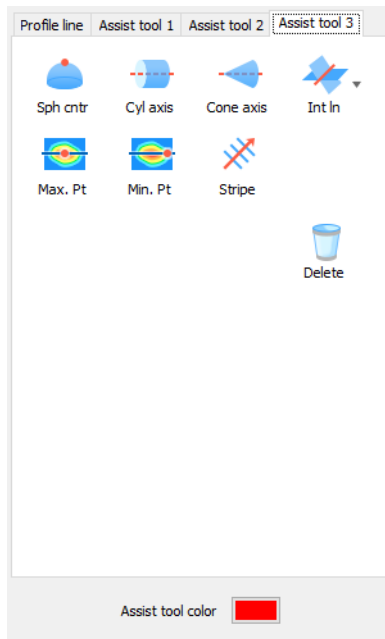
The measurement line is determined.

## [Assist tool] tab

Elements you create using the assist tool are called assist elements. Assist elements do not create any measurement lines, instead, they can be used as an assist point or assist line.

Placing assist elements at measurement points, enables you to set measurement lines more accurately and efficiently.





The following describes the function of each button and checkbox.

**[Edge detect] checkbox**

When this is selected, an edge is extracted automatically from around the place you clicked. Choose how to extract the edges from the pull-down list.

**[Multi-pt input] checkbox**

When this is selected, a figure is determined from more than one point using the least squares method. This checkbox cannot be used for [Point]

**[Specify value] checkbox**

When this checkbox is selected, the figure will be determined after specifying a value. Only used with [Circle], [Parallel] and [Spc angle].

**[Edit] button**

Clicking this button with an [Assist tool 2] element selected let you re-edit the element extraction.

**[Assist tool 1] icon**



Specifies one arbitrary point.  
 [Point] button (Page A-33)



Specifies a straight line that passes through arbitrary two points.  
 [Line] button (Page A-34)



Specifies a line segment that connects two points specified arbitrarily.  
 [Line] button (Assist tool 1) (Page A-34)



Specifies a circle that passes through arbitrary three points.  
 [Circle] button (Assist tool 1) (Page A-35)



Specifies an arc that passes through arbitrary three points.  
 [Arc] button (Assist tool 1) (Page A-36)



Specifies a straight line parallel to the line passes through two arbitrary points.  
 [Parallel] button (Page A-36)



Specifies a straight line intersecting the line passes through two arbitrary points at a specified angle. This item is selectable when the [Specify value] checkbox is selected.  
 [Spc angle] button (Page A-37)



Specifies the middle point between two points.  
 [Mid pt] button (Page A-37)



Specifies the intersection of two lines, a line and a circle, or two circles.  
 [Int pt] button (Page A-38)



Specifies a line that connects multiple line.  
 [Conct ln] button (Page A-39)



Specifies a circle that connects multiple circles.  
 [Conct cl] button (Page A-39)



Creates the bisector of two lines, a line and a point, or two points as line element.  
 [Bisector] Button (Page A-40)



Specifies a line which is perpendicular to the line passes through arbitrary two points.  
 [Perp.] button (Page A-40)

**[Assist tool 2] icon**



Generate the line generated from the edge element of the specified line segment element as the line element.  
 [Line] button (Assist tool 2) (Page A-41)



Generate the circle generated from the edge element of the specified circle (concentric circle) element as the circle element.

📖 [Circle] button (Assist Tool 2) (Page A-42)



Generate the arc generated from the edge element of the specified arc (concentric arc) element as the circle element.

📖 [Arc] button (Assist Tool 2) (Page A-43)

### [Assist tool 3] icon



Specifies a point at which the perpendicular line to the reference plane from the center point of a sphere estimated from the stereoscopic shape in the specified area and the reference plane intersect with each other.

📖 [Sph cntr] button (Page A-44)



Specifies a center axis of the cylinder estimated from the stereoscopic shape in the specified area.

📖 [Cyl axis] button (Page A-44)



Specifies a center axis of the cone estimated from the stereoscopic shape in the specified area.

📖 [Cone axis] button (Page A-45)



Specifies a cross line of the planes estimated from the stereoscopic shape in the specified area.

📖 [Int In] button (Page A-45)



Specifies the maximum point in the Z direction within the specified interval.

📖 [Max. Pt] button (Page A-46)



Specifies the minimum point in the Z direction within the specified interval.

📖 [Min. Pt] button (Page A-47)



Estimates and specifies a directional pattern passing through the point within the specified area.

📖 [Stripe] button (Page A-47)



Within the specified area, the height difference value that subtracted the reference data from the measurement data specifies the maximum point. (In relation to the measurement data, the measurement data gets convex on the most positive side.)

📖 [Max. diff.] button (Page A-48)



When the height difference image is being displayed with the comparative measurement or 3D-CAD comparative measurement [Max. Pt] is changed to [Max. diff.].



Within the specified area, the height difference value that subtracted the reference data from the measurement data specifies the maximum point. (In relation to the measurement data, the measurement data gets concave on the most negative side.)

📖 [Min. diff.] button (Page A-48)



When the height difference image is being displayed with the comparative measurement or 3D-CAD comparative measurement [Min. Pt] is changed to [Min. diff].

### Common icon



Deletes the placed element.

### How to use the assist tool

#### ■ [Point] button



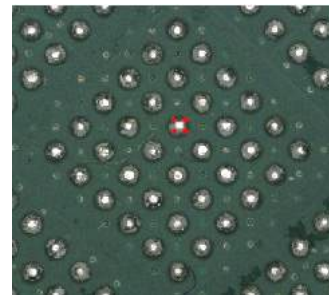
An element that expresses a point.

Reusable element at the time of placement

None

Reusable element after the placement

Point



**1** Click the [Point] button.

**2** Click an arbitrary position.

A point is placed.

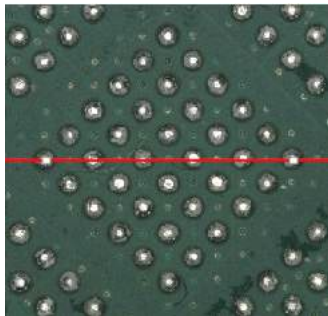
### ■ [Line] button



A straight line element that passes through two points (or more when [Multi-pt input] is selected).

Reusable element at the time of placement  
Point

Reusable element after the placement  
Line



- 1 Click the [Line] button.**
- 2 Click the first arbitrary point, and move the mouse pointer.**  
When you move the mouse pointer, a straight line is displayed.
- 3 Click the second arbitrary point.**  
The straight line that passes through the specified two points is placed.

### ■ [Line] button (Assist tool 1)



A straight line element that passes through two points.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Line segment



- 1 Click the [Line] button of [Assist tool 1].**
- 2 Click the first arbitrary point, and move the mouse pointer.**  
When you move the mouse pointer, the line segment that sets the first point as the start point appears.
- 3 Click the second arbitrary point.**  
The line segment that connects two points specified arbitrarily is placed.

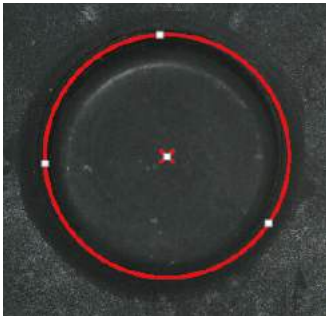
## ■ [Circle] button (Assist tool 1)



A circle element that specifies three points (or more when [Multi-pt input] is selected) on the circumference.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Point (center point of a circle), circle



## ● When the auto extract edge is deselected

- 1** Click the [Circle] button of [Assist tool 1].
- 2** Click the first point on the edge of the circle, and move the mouse pointer.
- 3** Click the second point on the circle, and move the mouse pointer.  
When you move the mouse pointer, a circle is enlarged/reduced accordingly.
- 4** Click the third circle point.

The circle that passes through the specified three points and the center point of the circle are placed.

## ● When the auto extract edge is selected

- 1** Click the [Circle] button of [Assist tool 1].
- 2** Select the measurement type.
 

Average diameter  
Max. diameter  
Min. diameter
- 3** Click the first point on the edge of the circle, and move the mouse pointer.
- 4** Click the second point on the circle, and move the mouse pointer.

When you move the mouse pointer, a circle is enlarged/reduced accordingly.

- 5** Click the third circle point.

The circle of the average diameter, max. diameter, min. diameter and the center point of the circle is placed according to the measurement type you selected.

## ■ [Arc] button (Assist tool 1)



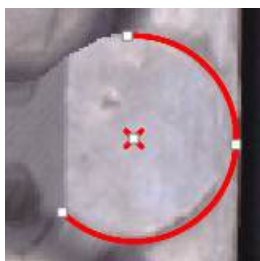
Generates an arc which is formed by three arbitrary points as the circle element.

Reusable element at the time of placement

Point

Reusable element after the placement

Point (center point of a circle), arc



- 1** Click the [Arc] button of [Assist tool 1].
- 2** Click the first point on the edge of the circle, and move the mouse pointer.
- 3** Click the second point on the circle, and move the mouse pointer.  
When you move the mouse pointer, a circle is enlarged/reduced accordingly.
- 4** Click the third circle point.

The arc formed by three specified points and the center point of the circle are placed.

## ■ [Parallel] button



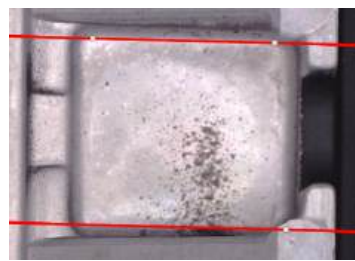
Generates a line which is parallel to the specified line.

Reusable element at the time of placement

Point, Line, Segment

Reusable element after the placement

Line



- 1** Click the [Parallel] button.
- 2** Click the first arbitrary point, and move the mouse pointer.  
When you move the mouse pointer, a straight line is displayed.
- 3** Click the 2nd point arbitrarily, and then move the mouse pointer.  
The reference line that passes through two specified points is placed.  
When you move the mouse pointer, a straight line is displayed.
- 4** Click a point arbitrarily.  
The line which is parallel to the reference line that passes through the clicked point is placed.

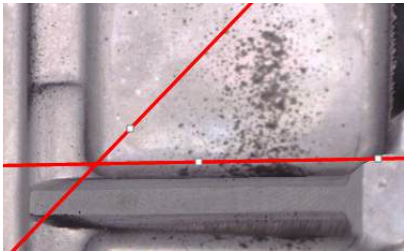
## ■ [Spc angle] button



Generates a line which is intersecting the line that passes through two points at a specified angle as line element.

Reusable element at the time of placement  
Point, Line, Segment

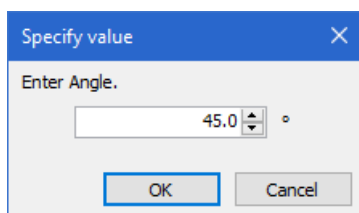
Reusable element after the placement  
Line



**1** Select the [Specify value] checkbox.

**2** Click the [Spc angle] button.

The [Specify value] dialog box appears.



**3** Enter an angle against the reference line and click the [OK] button.

**4** Click the first arbitrary point, and move the mouse pointer.

When you move the mouse pointer, a straight line is displayed.

**5** Click the 2nd point arbitrarily, and then move the mouse pointer.

The reference line that passes through two specified points is placed.

When you move the mouse pointer, a straight line is displayed.

**6** Click a point arbitrarily.

The line which is intersecting with the reference line at the specified angle is placed.

## ■ [Mid pt] button



Creates a middle point of two points as a point element.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Point (Middle point)



**1** Click the [Mid pt] button.

**2** Click the first arbitrary point, and move the mouse pointer.

When you move the mouse pointer, the line segment and the middle point appear.

**3** Click the second arbitrary point.

The middle point of the specified two points is placed.

## ■ [Int pt] button



Creates the intersection of two lines, a line and a circle, or two circles as a point element.

Reusable element at the time of placement

Point, Circle, Arc, Line, Segment

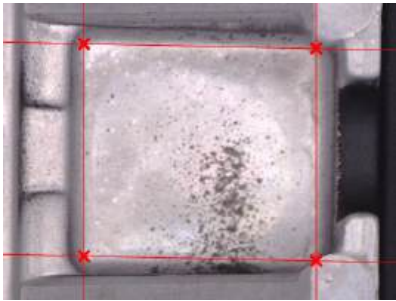
Reusable element after the placement

Point (intersection), Point (center point of the circle),

Circle, Line

## ● Batch extract

Extracts the intersections of assist tool at a time.

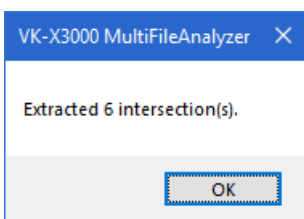


**1** Click the [Int pt] button.

**2** Select [Batch extract] from the displayed menu.

The intersection extract dialog box appears.

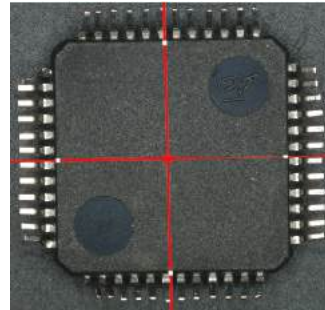
**3** Click the [OK] button.



**4** The intersection points are placed.

## ● Other than batch extract

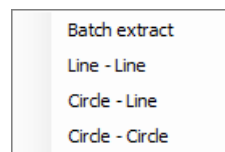
Draw a line with the measurement type selected, and extract its intersection.



(Measurement type:  
when line - line is specified)

**1** Click the [Int pt] button.

**2** Select the measurement type.



**3** Specify the 1st line or circle.

Specify a line and a circle in the same way as [Line] and [Circle].

**4** Specify the 2nd line or circle.

Specify a line and a circle in the same way as [Line] and [Circle].

When you specify them, the intersection of line and line, circle and line, or circle and circle is placed according to the measurement type you selected.

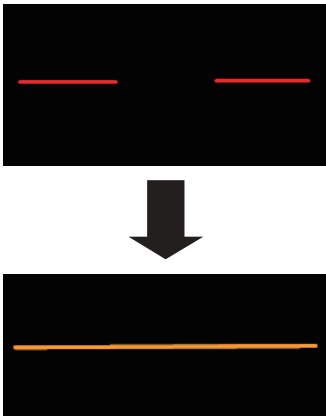
### ■ [Conct ln] button



Generates a line that connects multiple lines as line element.

Reusable element at the time of placement  
Point, Line, Segment

Reusable element after the placement  
Line



- 1** Click the [Conct ln] button.
- 2** Select an existing line element or point element.
- 3** Repeat Step 2.  
Up to 10 elements can be selected.
- 4** When you have finished selecting, double-click any point or select [Confirm] from the right-click menu.  
A new line element is placed based on the selected point elements and the sets of points that created the line elements.

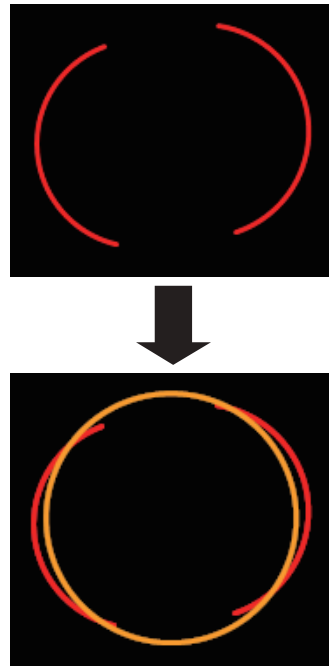
### ■ [Conct cl] button



Generates a circle that connects multiple circles as circle element.

Reusable element at the time of placement  
Point, Circle

Reusable element after the placement  
Circle



- 1** Click the [Conct cl] button.
- 2** Select an existing circle element or point element.
- 3** Repeat Step 2.  
Up to 10 elements can be selected.
- 4** When you have finished selecting, double-click any point or select [Confirm] from the right-click menu.  
A new circle element is placed based on the selected point elements and the sets of points that created the circle elements.

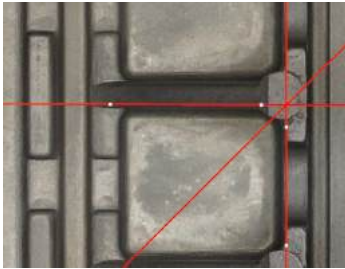
## ■ [Bisector] Button



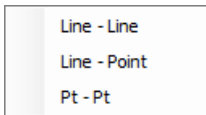
Creates the bisector of two lines, a line and a point, or two points as line element.

Reusable element at the time of placement  
Point, Line, Segment

Reusable element after the placement  
Line (Bisector)



- 1 Click the [Bisector] button.
- 2 Select the measurement type.



- 3 Specify the 1st line or point.  
Specify a straight line or point in the same way as [Line] or [Point].
- 4 Specify the 1st line or point.  
Specify a straight line or point in the same way as [Line] or [Point].  
A bisector is placed.  
After selecting [Line-Line] in measurement type, if the specified two lines are intersecting, go to the next step.
- 5 Click the interior angle (or the exterior angle) that intersects the two straight lines which were specified.  
The bisector in the interior angle (or exterior angle) intersected by the two specified lines is placed.

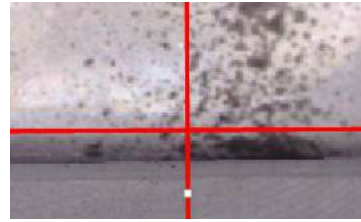
## ■ [Perp.] button



Generates a line perpendicular to the specified line.

Reusable element at the time of placement  
Point, Line, Segment

Reusable element after the placement  
Line



- 1 Click the [Perp.] button.
- 2 Click the first arbitrary point, and move the mouse pointer.  
When you move the mouse pointer, a straight line is displayed.
- 3 Click the 2nd point arbitrarily, and then move the mouse pointer.  
The reference line that passes through two specified points is placed.  
When you move the mouse pointer, a straight line is displayed.
- 4 Click a point arbitrarily.  
The line which is perpendicular to the reference line that passes through the clicked point is placed.

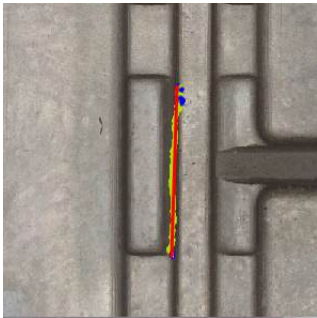
## ■ [Line] button (Assist tool 2)



Generate the line generated from the edge element of the specified line segment element as the line element.

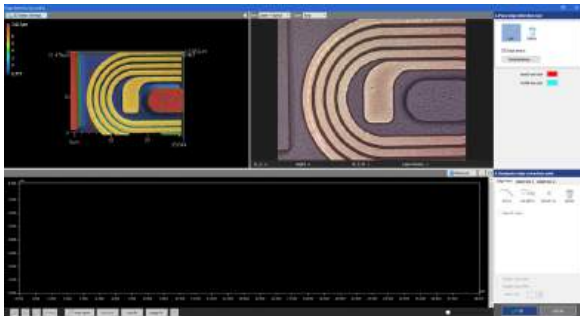
Reusable element at the time of placement  
None

Reusable element after the placement  
Line segment



### 1 Click the [Line] button of [Assist tool 2].

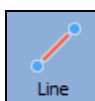
The [Edge detection by profile] window appears.



Each name and function part of the [Edge detection by profile] window is almost as the same as the [Profile] window.

Screen Used for Profile Measurement (Page 6-3)

### 2 Set the extracting method of the edge detection line from [1. Place edge detection tool].



Extract the edge line of the line segment that draws between two arbitrary specified points.

### 3 Specify the line segment element.

The edge line to the specified element is extracted, and the profile line of the edge line is displayed in the profile display area.



- By default settings, 100 edge lines are extracted. When changing the number of edge lines, click the [Detail settings] button.
- Specifying method of the line segment element  
 [Line] button (Page A-49)

### 4 Change the length of the edge line as required.

### 5 Select the [Assist tool] tab of [2. Designate edge extraction point], and click the desired button to place an element on the image as needed.

Types and Setting of Measurement Intervals (Page 6-12)

How to use assist tools (Page 6-25)

### 6 Click the desired button on the [Edge point] tab of [2. Designate edge extraction point], and set an area on the profile.

The line segment is created from the generated edge element.

How to Use the Edge Point Tool (Page A-51)



- The enabled edge point is displayed in yellow green, whereas the point where the edge extraction failed in blue.
- When the [Display all profiles] checkbox is selected, all profile lines that become the base of the edge element are displayed.  
When failing to extract the edge, adjust the detection area of the edge element so that all displayed profile lines are included.

### 7 Click the [OK] button.

The generated line segments are placed as elements.

## ■ [Circle] button (Assist Tool 2)



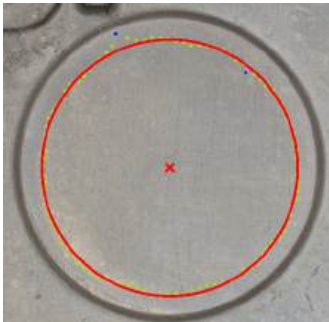
Generate the circle generated from the edge element of the specified circle (concentric circle) element as the circle element.

Reusable element at the time of placement

None

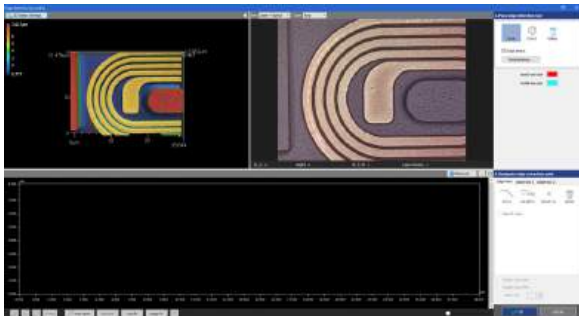
Reusable element after the placement

Point (center point of a circle), circle



### 1 Click the [Circle] button of [Assist tool 2].

The [Edge detection by profile] window appears.



Each name and function part of the [Edge detection by profile] window is almost as the same as the [Profile] window.

Screen Used for Profile Measurement (Page 6-3)

### 2 Set the extracting method of the edge detection line from [1. Place edge detection tool].



Extract the edge line of the arc that is configured by three arbitrary specified points.



Extract the edge line of the circles that are the same in the center point but different in radius from the arc configured by three arbitrary specified points.

### 3 Specify the circle element.

The edge line to the specified element is extracted, and the profile line of the edge line is displayed in the profile display area.



- By default settings, 100 edge lines are extracted. When changing the number of edge lines, click the [Detail settings] button.

- How to specify a circle  
 [Circle] button (Page A-49)

- How to specify concentric circles  
 [CnCrD] button (Page A-50)

### 4 Change the length of the edge line as required.

### 5 Select the [Assist tool] tab of [2. Designate edge extraction point], and click the desired button to place an element on the image as needed.

Types and Setting of Measurement Intervals (Page 6-12)

How to use assist tools (Page 6-25)

### 6 Click the desired button on the [Edge point] tab of [2. Designate edge extraction point], and set an area on the profile.

The circle is created from the generated edge element.

How to Use the Edge Point Tool (Page A-51)



- The enabled edge point is displayed in yellow green, whereas the point where the edge extraction failed in blue.
- When the [Display all profiles] checkbox is selected, all profile lines that become the base of the edge element are displayed.  
When failing to extract the edge, adjust the detection area of the edge element so that all displayed profile lines are included.

### 7 Click the [OK] button.

The generated circles are placed as elements.

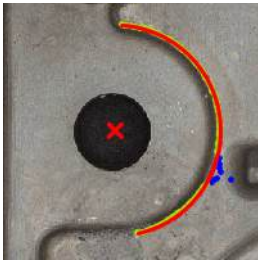
## ■ [Arc] button (Assist Tool 2)



Generate the arc generated from the edge element of the specified arc (concentric arc) element as the circle element.

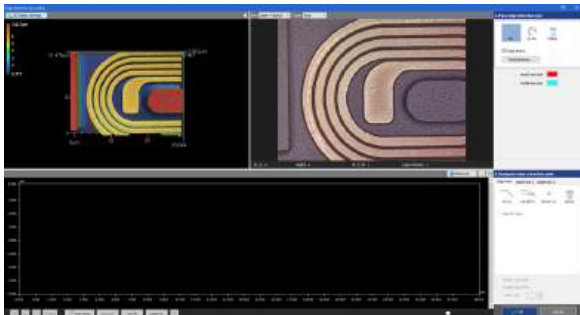
Reusable element at the time of placement  
None

Reusable element after the placement  
Point (center point of a circle), arc



### 1 Click the [Arc] button of [Assist tool 2].

The [Edge detection by profile] window appears.



Each name and function part of the [Edge detection by profile] window is almost as the same as the [Profile] window.

Screen Used for Profile Measurement (Page 6-3)

### 2 Set the extracting method of the edge detection line from [1. Place edge detection tool].



Extract the edge line of the arc that is configured by three arbitrary specified points.



Extract the edge line of the arcs that are the same in the center point but different in radius from the arc configured by three arbitrary specified points.

### 3 Specify the circle element.

The edge line to the specified element is extracted, and the profile line of the edge line is displayed in the profile display area.



- By default settings, 100 edge lines are extracted. When changing the number of edge lines, click the [Detail settings] button.
- How to specify an arc  
 [Arc] button (Page A-50)
- How to specify concentric arcs  
 [Cn Arc] button (Page A-51)

### 4 Change the length of the edge line as required.

### 5 Select the [Assist tool] tab of [2. Designate edge extraction point], and click the desired button to place an element on the image as needed.

Types and Setting of Measurement Intervals (Page 6-12)

How to use assist tools (Page 6-25)

### 6 Click the desired button on the [Edge point] tab of [2. Designate edge extraction point], and set an area on the profile.

The arc is created from the generated edge element.

How to Use the Edge Point Tool (Page A-51)



- The enabled edge point is displayed in yellow green, whereas the point where the edge extraction failed in blue.
- When the [Display all profiles] checkbox is selected, all profile lines that become the base of the edge element are displayed.  
When failing to extract the edge, adjust the detection area of the edge element so that all displayed profile lines are included.

### 7 Click the [OK] button.

The generated arcs are placed as elements.

## ■ [Sph cntr] button



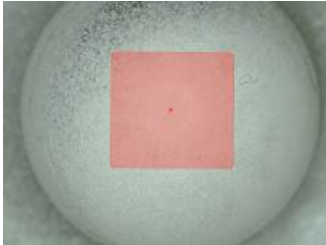
The stereoscopic shape in the specified area being considered as a sphere, create a point element of the point at which the perpendicular line to the reference plane from the center point of the sphere and the reference plane intersect with each other.

Reusable element at the time of placement

Point

Reusable element after the placement

Point (center point of the sphere)



- 1** Click the [Sph cntr] button.
- 2** Click the starting point of the area, and move the mouse pointer.  
When you move the mouse pointer, a straight line is displayed.
- 3** Click the second point of the area, and move the mouse pointer.  
When you move the mouse pointer, a translucent triangle appears.
- 4** Repeat step 3, and double-click the mouse at the position that should be the end point of the figure.

Every time you click on an arbitrary place, a continuous line appears.

The area is determined after double-clicking on the last apex, and the sphere center point is placed.

## ■ [Cyl axis] button



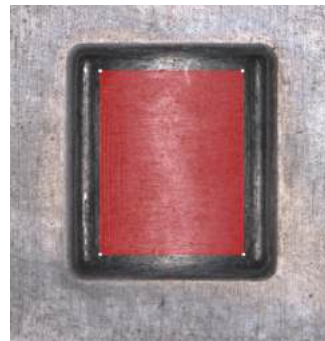
The stereoscopic shape in the specified tetragon being considered as a side surface of a cylinder, creates a straight line element of the line whose center axis is projected to the reference plane.

Reusable element at the time of placement

Point

Reusable element after the placement

Straight line (center axis of the cylinder)



- 1** Click the [Cyl axis] button.  
The steps after this are the same as those for [Sph cntr].  
When the tetragon is confirmed, the straight line of the center axis of the cylinder is placed.



Do not specify an area that spreads out of the cylinder (or the stereoscopic shape). (as well as sphere and cone)

If the area spreads out of the cylinder, the software will factor the surrounding data into the cylindrical approximation. In this case, an accurate axis cannot be calculated.

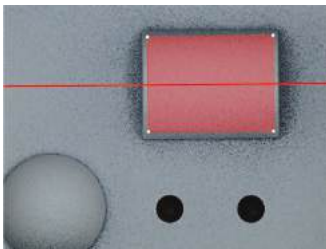
## ■ [Cone axis] button



The stereoscopic shape in the specified tetragon being considered as a side surface of a cone, creates a straight line element of the line whose center axis is projected to the reference plane.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Straight line (center axis of the cone)



### 1 Click the [Cone axis] button.

The steps after this are the same as those for [Sph cntr].

When the tetragon is confirmed, the straight line of the center axis of the cone is placed.

## ■ [Int In] button



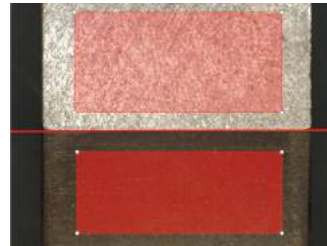
Specifies a cross line of the planes estimated from the stereoscopic shape in the specified area.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Straight line (surface intersection line)

### ● Reference surface - Free surface

Creates an intersection line between the reference surface and a surface specified arbitrarily.



### 1 Click the [Int In] button.

A menu to select a type of plane appears on the button.

### 2 Select [Reference surface - Free surface] from the menu.

### 3 Click the starting point of the area, and move the mouse pointer.

When you move the mouse pointer, a straight line is displayed.

### 4 Click the second point of the area, and move the mouse pointer.

When you move the mouse pointer, a translucent triangle appears.

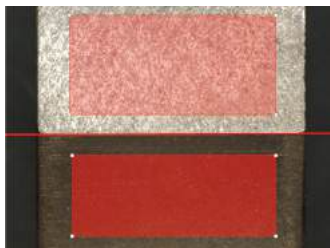
### 5 Repeat step 4, and double-click the mouse at the position that should be the end point of the figure.

Every time you click on an arbitrary place, a continuous line appears.

An arbitrary area is determined after double-clicking on the last apex, and the straight line of the surface intersection line is placed.

### ● Free surface - Free surface

Creates an intersection line between the two surfaces specified arbitrarily.



#### 1 Click the [Int In] button.

A menu to select a type of plane appears on the button.

#### 2 Select [Free surface - Free surface] from the menu.

#### 3 Click the starting point of the area, and move the mouse pointer.

When you move the mouse pointer, a straight line is displayed.

#### 4 Click the second point of the area, and move the mouse pointer.

When you move the mouse pointer, a translucent triangle appears.

#### 5 Repeat step 4, and double-click the mouse at the position that should be the end point of the figure.

Every time you click on an arbitrary place, a continuous line appears.

The first surface is determined after double-clicking on the last apex.

#### 6 Repeat steps 3 through 5 to specify the second surface.

The second surface is confirmed, and the straight line of the surface intersection line is placed.

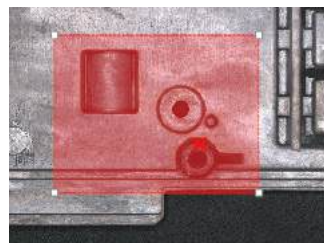
### ■ [Max. Pt] button



Generates the maximum point as a point element in the Z direction within the specified area.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Point (Maximum point)



#### 1 Click the [Max. Pt] button.

#### 2 Click the starting point of the area, and move the mouse pointer.

When you move the mouse pointer, the line segment appears.

#### 3 Click the place that becomes the apex of the second point, and move the mouse pointer.

When you click the mouse at the second point, a straight line is determined.

#### 4 Repeat step 3, and double-click the mouse at the position that should be the end point of the figure.

Every time you click on an arbitrary place, a continuous line appears.

The area is determined after double-clicking on the last apex, and the maximum point is placed.

## ■ [Min. Pt] button



Generates the minimum point as point element in the Z direction within the specified area.

Reusable element at the time of placement  
Point

Reusable element after the placement  
Point (Minimum point)



- 1** Click the [Min. Pt] button.
- 2** Click the starting point of the area, and move the mouse pointer.  
When you move the mouse pointer, the line segment appears.
- 3** Click the place that becomes the apex of the second point, and move the mouse pointer.  
When you click the mouse at the second point, a straight line is determined.
- 4** Repeat step 3, and double-click the mouse at the position that should be the end point of the figure.  
Every time you click on an arbitrary place, a continuous line appears.  
The area is determined after double-clicking on the last apex, and the minimum point is placed.

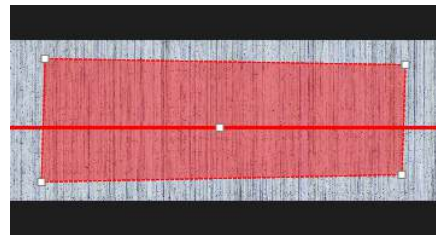
## ■ [Stripe] button



Generates a line element from the directional pattern passing through the point within the specified area.

Usable element at the time of placement  
Point

Usable element after the placement  
Point



- 1** Click the [Stripe] button.
- 2** Click the starting point of the area, and move the mouse pointer.  
When you move the mouse pointer, the line segment appears.
- 3** Click the place that becomes the apex of the second point, and move the mouse pointer.  
When you click the mouse at the second point, a straight line is determined.
- 4** Repeat step 3, and double-click the mouse at the position that should be the end point of the figure.  
Every time you click on an arbitrary place, a continuous line appears.  
The area is determined after double-clicking on the last apex.
- 5** Click a point arbitrarily.  
A line is placed.

### ■ [Max. diff.] button



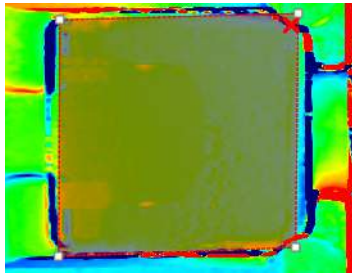
Within the specified area, the height difference value that subtracted the reference data from the measurement data generates the maximum point as point element. (In relation to the measurement data, the measurement data gets convex on the most positive side.).

Reusable element at the time of placement

Point

Reusable element after the placement

Point (Maximum point)



**1** Click the [Max. diff.] button.

**2** Click the starting point of the area, and move the mouse pointer.

When you move the mouse pointer, the line segment appears.

**3** Click the place that becomes the apex of the second point, and move the mouse pointer.

When you click the mouse at the second point, a straight line is determined.

**4** Repeat step 3, and double-click the mouse at the position that should be the end point of the figure.

Every time you click on an arbitrary place, a continuous line appears.

The area is determined after double-clicking on the last apex, and the maximum point is placed.

### ■ [Min. diff.] button



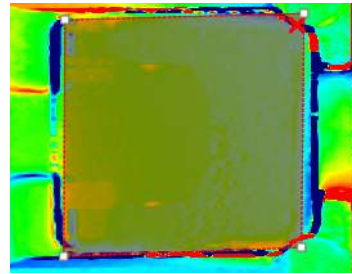
Within the specified area, the height difference value that subtracted the reference data from the measurement data generates the minimum point as point element. (In relation to the measurement data, the measurement data gets concave on the most negative side.).

Reusable element at the time of placement

Point

Reusable element after the placement

Point (Minimum point)



**1** Click the [Min. diff.] button.

**2** Click the starting point of the area, and move the mouse pointer.

When you move the mouse pointer, the line segment appears.

**3** Click the place that becomes the apex of the second point, and move the mouse pointer.

When you click the mouse at the second point, a straight line is determined.

**4** Repeat step 3, and double-click the mouse at the position that should be the end point of the figure.

Every time you click on an arbitrary place, a continuous line appears.

The area is determined after double-clicking on the last apex, and the minimum point is placed.

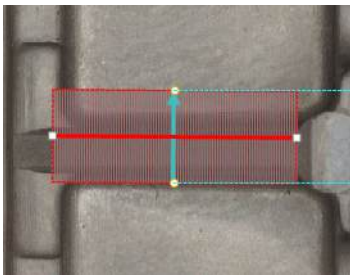
## How to Use the Edge Detection Line Placement Tool

The following describes how to detect an edge by the edge detection line placement tool.

### ■ [Line] button



Extract the edge line of the line segment that draws between two arbitrary specified points.

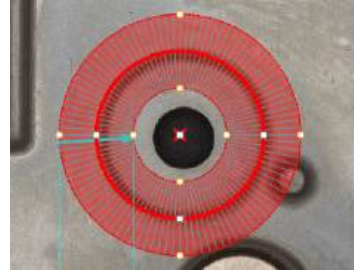


- 1** Click the [Line] button of [1. Place edge detection tool].
- 2** Click the first arbitrary point, and move the mouse pointer.  
When you move the mouse pointer, the line segment that sets the first point as the start point appears.
- 3** Click the second arbitrary point.  
The edge line of the line segment is extracted.

### ■ [Circle] button

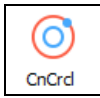


Extract the edge line of the arc that is configured by three arbitrary specified points.

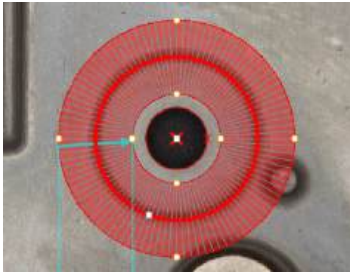


- 1** Click the [Circle] button of [1. Place edge detection tool].
- 2** Click the first point on the edge of the circle, and move the mouse pointer.
- 3** Click the second point on the circle, and move the mouse pointer.  
When you move the mouse pointer, a circle is enlarged/reduced accordingly.
- 4** Click the third circle point.  
The edge line of the circle is extracted.

## ■ [CnCrđ] button



Extract the edge line of the circles that are the same in the center point but different in radius from the arc configured by three arbitrary specified points.



**1** Click the [CnCrđ] button of [1. Place edge detection tool].

**2** Click the first point on the edge of the circle, and move the mouse pointer.

**3** Click the second point on the circle, and move the mouse pointer.

When you move the mouse pointer, a circle is enlarged/reduced.

**4** Click the third point on the circle, and move the mouse pointer.

When you click the third point on the periphery, the circle that passes through the specified three points is displayed. When you move the mouse pointer, the circle of which the center point is the same as the displayed circle and where the mouse pointer position is the radius is displayed.

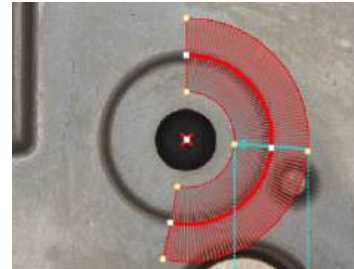
**5** Click it on the position to be placed.

The edge line of the concentric circle is extracted.

## ■ [Arc] button



Extract the edge line of the arc that is configured by three arbitrary specified points.



**1** Click the [Arc] button of [1. Place edge detection tool].

**2** Click the first point on the edge of the circle, and move the mouse pointer.

**3** Click the second point on the circle, and move the mouse pointer.

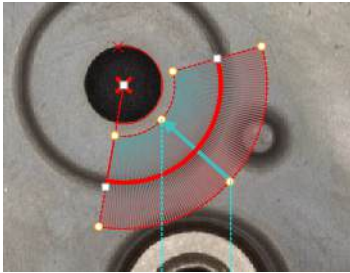
**4** Click the third circle point.

The edge line of the arc is extracted.

## ■ [Cn Arc] button



Extract the edge line of the arcs that are the same in the center point but different in radius from the arc configured by three arbitrary specified points.



- 1** Click the [Cn Arc] button of [1. Place edge detection tool].
- 2** Click the first point on the edge of the circle, and move the mouse pointer.
- 3** Click the second point on the circle, and move the mouse pointer.
- 4** Click the third circle point.

When you click the third point on the periphery, the arc formed from the specified three points is displayed.

- 5** Click the arc on the position to be placed.

An arc with the center point that is the same as the arc created in Step 4 and the radius on the clicked positions is displayed.

Dragging the mouse changes the arc range.

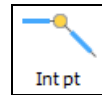
- 6** Click it on the position to be placed.

The edge line of the concentric arc is extracted.

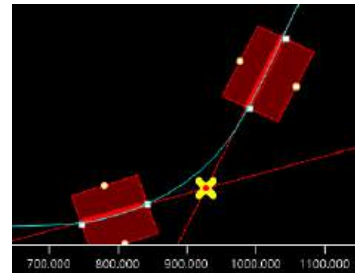
## How to Use the Edge Point Tool

The following describes how to set the measurement line by the edge point tool.

### ■ [Int pt] button



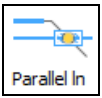
Generate the intersection between two intervals on the profile line as the edge element.



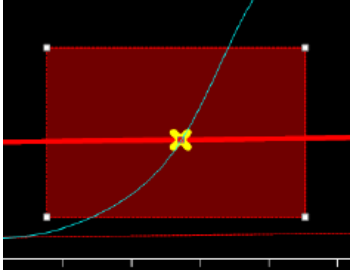
- 1** Click the [Int pt] button.
- 2** Specify Line 1.
- 3** Specify Line 2.

The edge element is generated.

## ■ [Parallel In] button

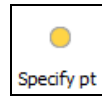


Generate one point on the profile lines which is on the straight parallel line that connects two points on the profile lines as the edge element.

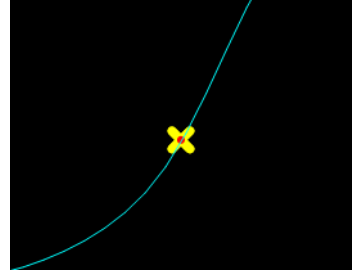


- 1** Click the [Parallel In] button.
- 2** Specify the line.
- 3** Specify the parallel line.
- 4** Specify the space where the edge is detected.  
The edge element is generated.

## ■ [Specify pt] button



Generate the element generated from the specified point as the edge element.



- 1** Place the point element by using the assist tool.



You cannot specify the point element directly by the [Specify pt] button.

Only the point element created by the assist tool can be specified.

Types and Setting of Measurement Intervals (Page 6-12)

How to use assist tools (Page 6-25)

- 2** Click the [Specify pt] button.
- 3** Click the point that you created in step 1.  
The edge element is generated.

## Using edge detections separately

There are two methods to detect the edge by the assist tool: the auto extract edge (the method to use the [Edge detect] checkbox) and profile edge extraction (the method to use [Assist tool 2]).

It is convenient when tools above are used separately as follows:

### ■ Auto Extract Edge

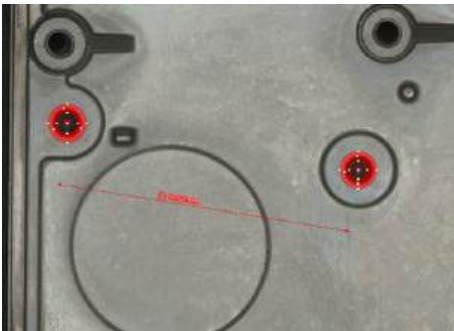
This is for an image where the parts contrast and height difference are clear.

For the auto extract edge, [Optical], [Laser], [Laser intens] and [Height] can be selected.

### ● Optical, Laser, Laser intens

This is for an object where the contrast of the optical image is clear in the edge part.

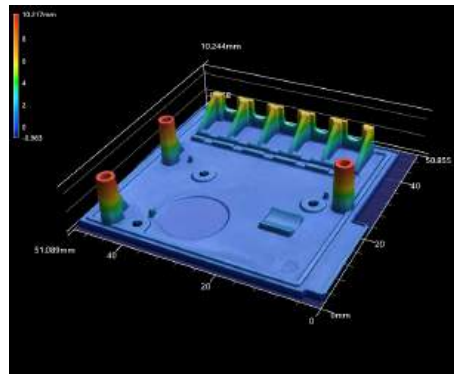
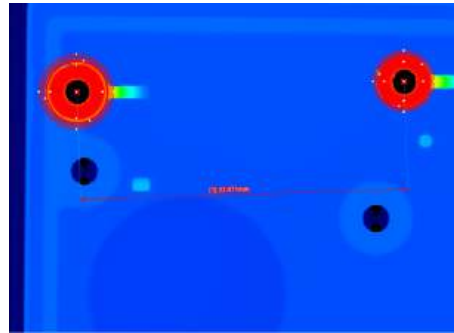
If capturing it with the monochrome or super fine, the accuracy increases.



### ● Height

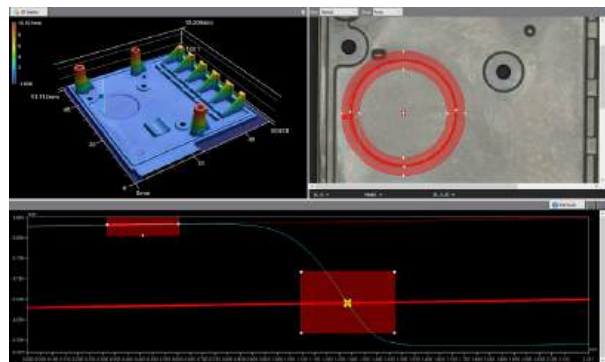
This is for an object where the height difference is clear.

This is not appropriate for a sample with curve and tilt, because it is hard to determine its border. This is effective for a sample of which profile is changing vertically, or of which tip from a certain remained part lacks.



### ■ Edge detection by profile

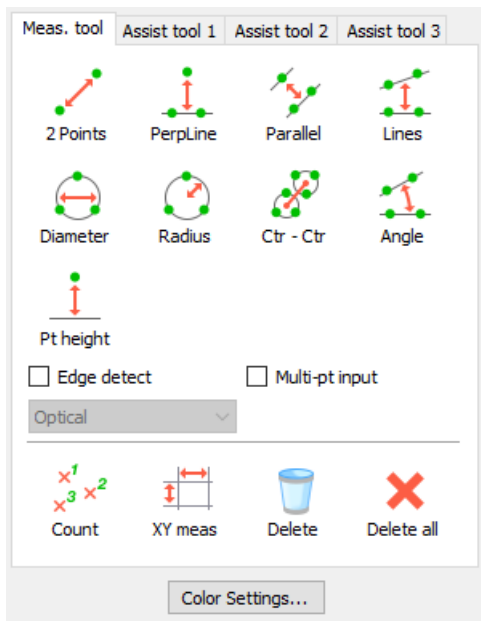
This is used for samples with low contrast and smooth shape. You can specify any point with intersections and assist elements to ensure that you are measuring the targeted location.



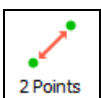
## Plane Measurement Tool

In the plane measurement tool, click a button of each tool to set various measurement lines. Click a tool button to select the tool. While the tool is selected, click in the image display area to place an element of the tool. Once the element is placed, the tool will be deselected.

When you draw a measurement line, you can measure values such as distance and angle of a specific section.

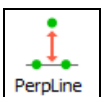


The following describes the function of each button and checkbox.



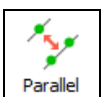
### [2 Points] button

This measures a distance between two points which are specified in any location.



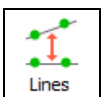
### [PerpLine] button

This measures the length of a line perpendicular from an arbitrary point to a reference line.



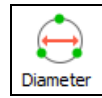
### [Parallel] button

This measures the distance between a reference line and an arbitrary parallel line.



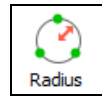
### [Lines] button

This measures the distance between a reference line and an arbitrary line (a midpoint between the two points that define the line).



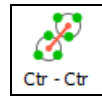
### [Diameter] button

Measures a diameter of the circle that passes through three points specified arbitrarily.



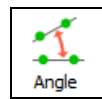
### [Radius] button

Measures a radius of the circle that passes through three points specified arbitrarily.



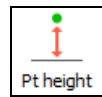
### [Ctr - Ctr] button

Measures a distance between the centers of two circles specified arbitrarily.



### [Angle] button

Measures an angle between two lines specified arbitrarily.

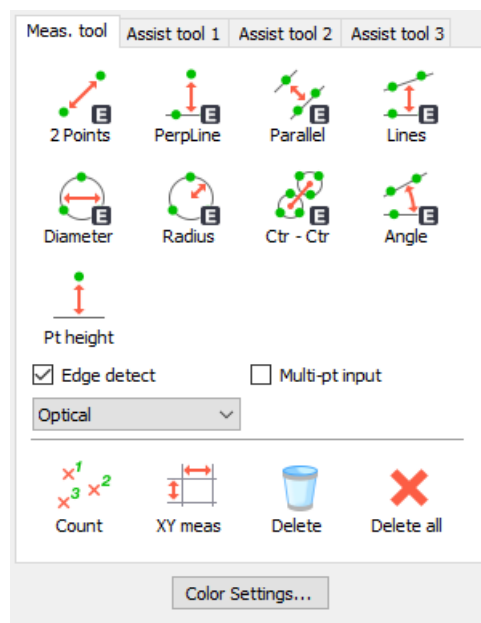


### [Pt height] button

Measures the point height from an arbitrary specified reference plane.

### ● [Edge detect] checkbox

When this is selected, an edge is extracted automatically from around the place you clicked, and the measurement line is corrected using the coordinates. When the [Edge detect] checkbox is selected, an E is displayed on the bottom right of the icon of each measurement tool for which the auto extract edge is available.

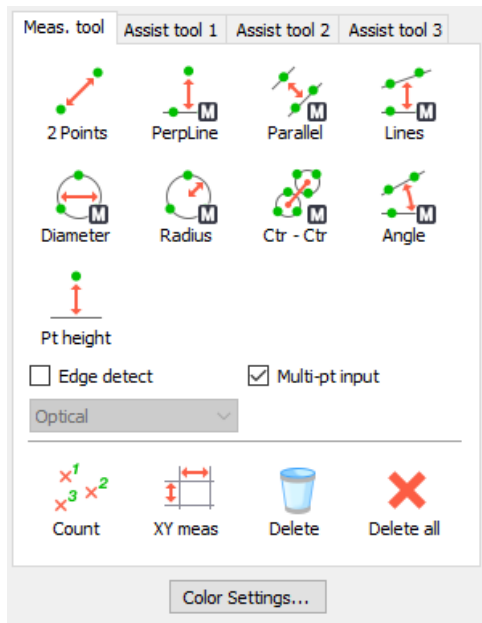


- The default setting of [Edge detect] checkbox is ON.
- The [Edge detect] checkbox and the [Multi-pt input] checkbox cannot be selected at the same time.

### ● [Multi-pt input] checkbox

When this is selected, a measurement line approximated from more than one point using the least squares method is displayed.

When the [Multi-pt input] checkbox is selected, an M is displayed on the bottom right of the icon of each measurement tool for which the multi-point input is available.



#### Point

- This function cannot be used for a "point" element.
- The [Edge detect] checkbox and the [Multi-pt input] checkbox cannot be selected at the same time.



#### [Count] button

Select the desired points on the image. These points will be counted.



#### [XY meas] button

Measures an X distance, Y distance, and diagonal distance of the area surrounded by the vertical/horizontal cursors.



#### [Delete] button

Deletes the selected measurement line.



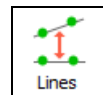
#### [Delete all] button

Deletes all the measurement lines you have created.

### How to use measurement tool

For how to draw a measurement line using [2 Points], [PerpLine], or [Parallel], refer to How to use profile line tool (Page A-26).

### ■ Measurement between straight lines



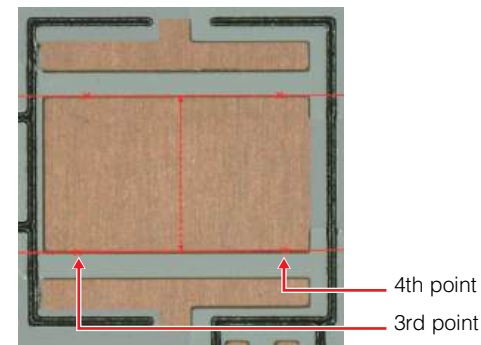
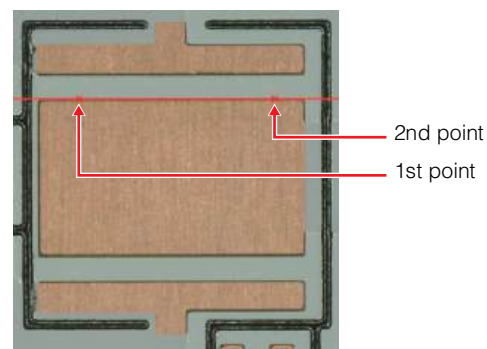
This measures the distance between a reference line and an arbitrary line (a midpoint between the two points that define the line).

Reusable element at the time of placement

Line, Point, Segment

Reusable element after the placement

Straight line (reference line, arbitrary straight line)



**1** Click the [Lines] button.

**2** Click the first arbitrary point, and move the mouse pointer.

When you move the mouse pointer, the line segment appears.

**3 Click the second arbitrary point.**

The straight line (reference line) that passes through the specified two points is placed.

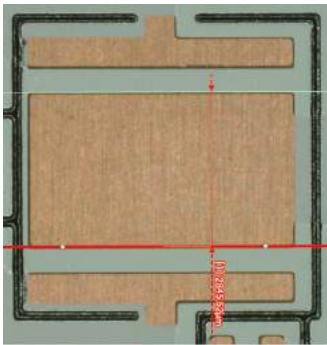
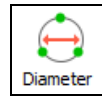
**4 Click the 3rd and 4th points arbitrarily.**

The straight line that passes through the specified two points is placed, and the measured value for the line that connects the reference line and the middle point of the two points is displayed.

The measured value follows the mouse pointer and is displayed in the measurement tool/results list.

**5 Click the position to display the measured value.**

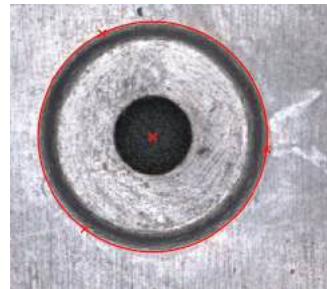
The position to display the measured value is determined.

**■ Measurement of a diameter**

Measures a diameter of the circle that passes through three points specified arbitrarily.

Reusable element at the time of placement  
Point, Circle

Reusable element after the placement  
Point (center point of a circle), circle

**1 Click the [Diameter] button.****2 Click the 1st point arbitrarily.**

The x symbol appears at the point you have clicked.

**3 Click the 2nd point arbitrarily, and then move the mouse pointer.**

The x symbol appears at the second point you have clicked.

Moving the mouse pointer enlarges or reduces the circle accordingly.

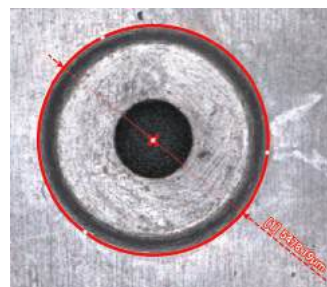
**4 Click the 3rd point arbitrarily.**

A circular measurement line that connects the three points is placed.

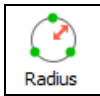
The measured value (the diameter of the circle) follows the mouse pointer and is displayed in the measurement tool/results list.

**5 Click the position to display the measured value.**

The position to display the measured value is determined.



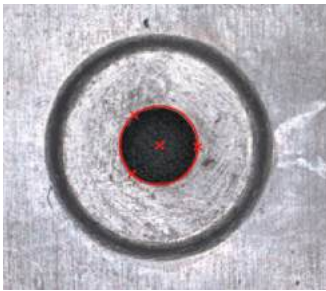
## ■ Measurement of a radius



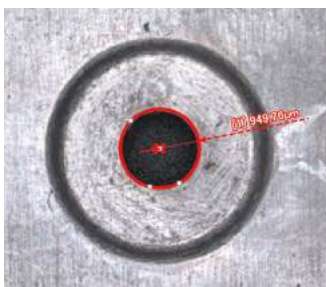
Measures a radius of the circle that passes through three points specified arbitrarily.

Reusable element at the time of placement  
Point, Circle, Segment

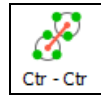
Reusable element after the placement  
Point (center point of a circle), circle



- 1 Click the [Radius] button.**
- 2 Click the 1st point arbitrarily.**  
The x symbol appears at the point you have clicked.
- 3 Click the 2nd point arbitrarily, and then move the mouse pointer.**  
The x symbol appears at the second point you have clicked.  
Moving the mouse pointer enlarges or reduces the circle accordingly.
- 4 Click the 3rd point arbitrarily.**  
A circular measurement line that connects the three points is placed.  
The measured value (the radius of the circle) follows the mouse pointer and is displayed in the measurement tool/results list.
- 5 Click the position to display the measured value.**  
The position to display the measured value is determined.



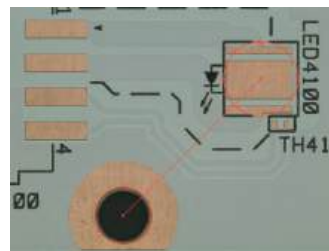
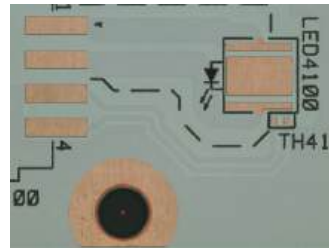
## ■ Measurement between center points of circles



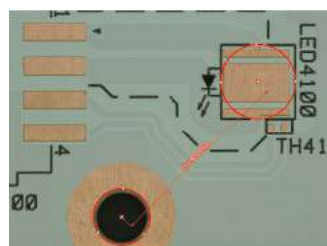
Measures a distance between the centers of two circles specified arbitrarily.

Usable element at the time of placement  
Point, Circle

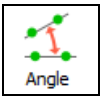
Usable element after the placement  
Point (center point of a circle), circle



- 1 Click the [Ctr - Ctr] button.**
- 2 Click three points on the circumference of one of the two circles you want to measure.**  
A circular measurement line that connects the three points is placed.
- 3 Click three points on the circumference of the other circle.**  
The other circular measurement line is placed, and the straight line that connects the two circle's centers (starting and end points) is placed.  
The measured value follows the mouse pointer and is displayed in the measurement tool/results list.
- 4 Click the position to display the measured value.**  
The position to display the measured value is determined.



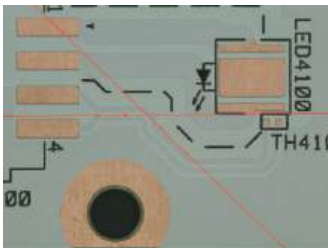
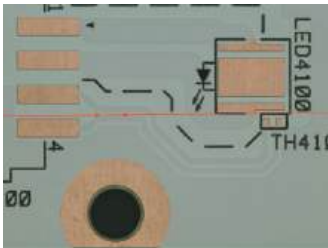
## ■ Measurement of the angle



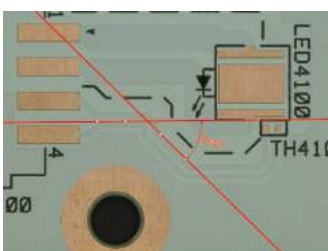
Measures the internal angle formed by the intersection of two straight lines.

Usable element at the time of placement  
Point, Line, Segment

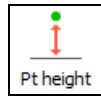
Usable element after the placement  
Line



- 1 Click the [Angle] button.**
- 2 Click two points (1st and 2nd points) on the first straight line that forms the angle.**  
The first straight line is placed.
- 3 Click two more points (3rd and 4th points) on another straight line.**  
An angle at the point of intersection of the specified two straight lines is displayed.
- 4 Click the position to display the measured value.**  
The position to display the measured value is determined.



## ■ Measurement of Point Height



Measures the point height from an arbitrary specified reference plane.



Usable element at the time of placement  
Point

Usable element after the placement  
Point

- 1 Click the [Pt height] button.**
- 2 Click a point arbitrarily.**  
The x symbol appears at the point you have clicked.  
The measured value follows the mouse pointer and is displayed in the measurement tool/results list.
- 3 Click the position to display the measured value.**  
The position to display the measured value is determined.



After placing the element, the tool keeps being able to be selected so you can continue placing elements.

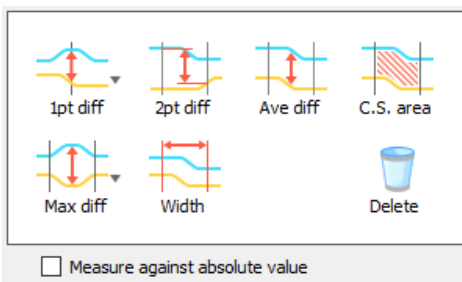
## Comparative Measurement Tool

In the comparative measurement tool, click a button of each tool to set various measurement intervals. Click a tool button to select the tool. While the tool is selected, click or drag in the profile display area to place an element of the tool. Once the element is placed, the tool will be deselected.

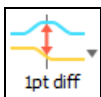
### Measurement tool

In the measurement tool, click a button of each tool to set various measurement intervals. Click a tool button to select the tool. While the tool is selected, click in the profile display area to place a vertical cursor. Once a vertical cursor is placed, the tool will be deselected.

When a measurement interval is set, difference of height, average of height difference, cross-sectional area, maximum value of height difference, and distance (length) in a certain interval can be measured.

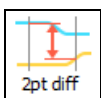


The following describes the function of each button and checkbox.



Measure the height difference between the measurement data and reference data taken along the vertical cursor, or, the distance in the profile direction from the reference data to the measurement data.

[1pt diff] button (Page A-60)



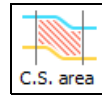
Measures the difference between heights of the reference image and the comparison image at the place specified with the two vertical cursors.

[2pt diff] button (Page A-60)



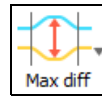
Measures the average value of the difference between heights of the reference image and the comparison image in the area surrounded by the two vertical cursors.

[Ave diff] button (Page A-61)



Measures the area of the part surrounded by the reference image and the comparison image in the area surrounded by the two vertical cursors.

[C.S. area] button (Page A-61)



Measures the maximum value of the differences between heights of the reference image and the comparison image in the area surrounded by the two vertical cursors.

[Max diff] button (Page A-61)



Measures the distance value between two vertical cursors in X direction.

[Width] button (Page A-62)



Deletes the specified measurement intervals.

### [Measure against absolute value] checkbox

When this checkbox is selected, measures the absolute value of the height difference. For example, for average difference, the absolute value of the height difference of each point in the interval is calculated and then the average of them is calculated.

## How to use measurement tool

The following describes how to set a measurement interval using the measurement tool.

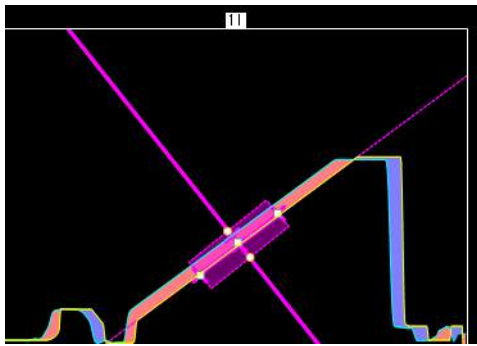
### ■ [1pt diff] button



Measure the height difference between the measurement data and reference data taken along the vertical cursor, or, the distance in the profile direction from the reference data to the measurement data.

### ● Profile direction

Measures the distance in vertical direction from the reference to the comparative target.



- 1** Click the [1pt diff] button.
- 2** Select [Profile direction] from the displayed menu.
- 3** Click the 1st point arbitrarily on the profile line of the reference side, and then move the mouse pointer.

When you move the mouse pointer, a straight line is displayed.

- 4** Move the mouse pointer, and click an arbitrary 2nd point on the profile line of the reference side.

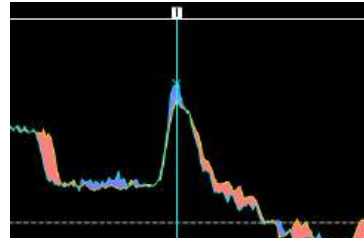
A line which is perpendicular to the line that passes through the specified two points is displayed.

- 5** Move the mouse pointer, and determine the position of the perpendicular line.

The measured value is displayed in the measurement list.

### ● Z axis direction

Measures the difference between heights of the reference image and the comparison image at the place specified with the one vertical cursor.



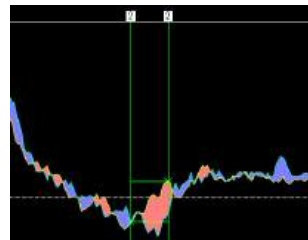
- 1** Click the [1pt diff] button.
- 2** Select [Z axis direction] from the displayed menu.
- 3** Specify the line.

The measured value is displayed in the measurement results list.

### ■ [2pt diff] button



Measures the difference between heights of the reference image and the comparison image at the place specified with the two vertical cursors.



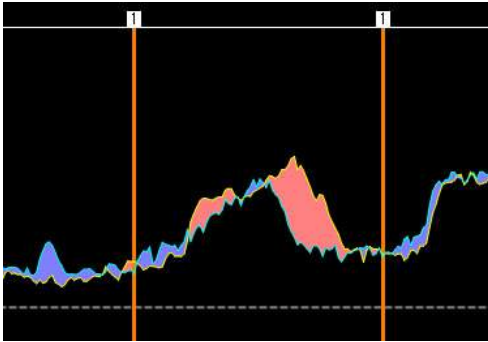
- 1** Click the [2pt diff] button.
- 2** Specify Line 1.
- 3** Specify Line 2.

The measured value is displayed in the measurement results list.

### ■ [Ave diff] button

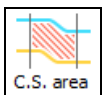


Measures the average value of the difference between heights of the reference image and the comparison image in the area surrounded by the two vertical cursors.

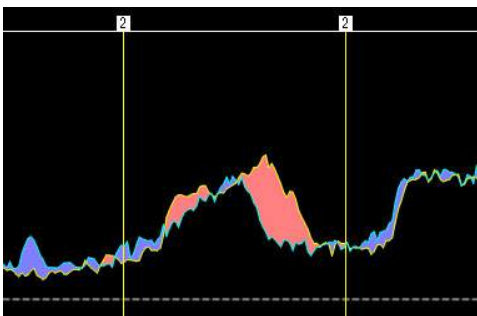


- 1 Click the [Ave diff] button.
- 2 Specify Line 1.
- 3 Specify Line 2.  
The measured value is displayed in the measurement list.

### ■ [C.S. area] button

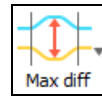


Measures the area of the part surrounded by the reference image and the comparison image in the area surrounded by the two vertical cursors.

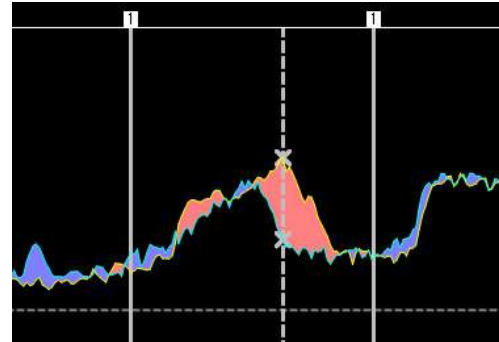


- 1 Click the [C.S. area] button.
- 2 Specify Line 1.
- 3 Specify Line 2.  
The measured value is displayed in the measurement list.

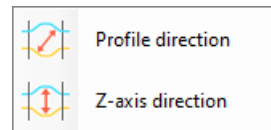
### ■ [Max diff] button



Measures the maximum value of the difference between heights of the reference image and the comparison image in the area surrounded by the two vertical cursors.

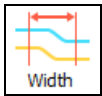


- 1 Click the [Max diff] button.
- 2 Select the measurement type.

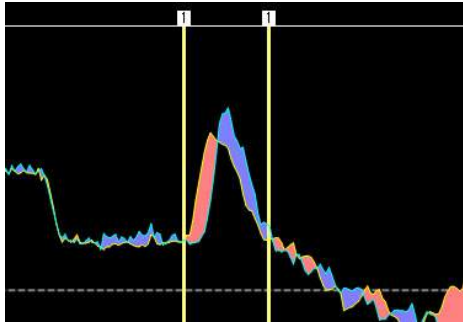


- 3 Specify Line 1.
- 4 Specify Line 2.  
The measured value is displayed in the measurement list.

## ■ [Width] button



Measures the distance value between two vertical cursors in X direction.



**1** Click the [Width] button.

**2** Specify Line 1.

**3** Specify Line 2.

The measured value is displayed in the measurement results list.

## Editing/Deleting Elements

This section describes editing/deleting of elements placed using the profile tool (including measurement lines).

### ■ Select

You can select elements by any of the following operations:

- Click a desired element in the image display area
- Select a desired element in the profile list

You can select more than one element at the same time by clicking them while pressing the Ctrl or Shift key.



In the image display area and the profile list, the selection status of element is synchronized. If you select an element in either area, it is selected and highlighted in both areas.

### ■ Resizing/moving

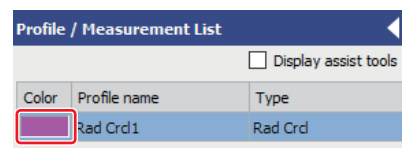
For further information on the resizing/moving, refer to

What is an Element? (Page A-22).

### ■ Changing rendering color

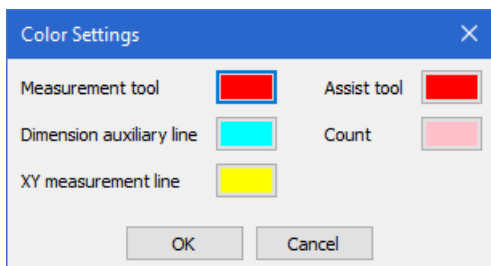
#### ● For profile measurement, line roughness measurement, and comparative measurement

You can change the color of the measurement line by clicking the [Color] color palette for the desired profile name in the profile list. The color of elements for the assist tools can be changed by clicking the [Assist tool color] color palette in the profile tool. You cannot specify the color of each element for the assist tools individually.



### ● For plane measurement

In the [Color settings] dialog box displayed by clicking the [Color settings] button in the plane measurement tool, you can select the display color of the measurement tool, the assist tool, etc. from the color palettes.



### ■ Rename

By default, the tool name of the profile tool followed by a sequential number is used as the name. For example, the first measurement result set by [2 Points] is "2 Points 1".

You can rename an element by any of the following operations in the profile list:

- Click the profile name in the row of the desired element.
- Select [Rename] from the right-click menu of the row of the desired element.

### ■ Delete

You can delete elements by any of the following operations while elements are selected.

- Press the Delete key.
- Select [Delete] from the right-click menu.
- Click the [Delete] button in the profile tool.

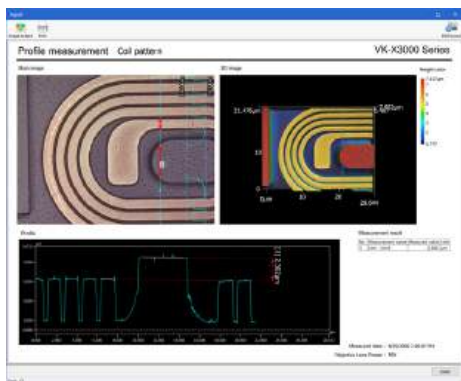
# Exporting Measurement Result

Profile measurement results can be output to a report or an Excel file

## ● Report output

Outputs the results in a defined format in another window.

Refer to [Report](#) (Page 3-9).



## ● Exporting to Excel file

Outputs the image data and text to Excel in grid display layout.

Use this function for statistical processing of measurement results or for creating a graph in Excel.

Refer to [Exporting as Excel File](#) (Page 3-15).

## ● Save CSV

Outputs the measurement result in CSV format.

Data in CSV format can be imported by spreadsheet software such as Microsoft Excel.

Refer to [Exporting measurement result](#) (Page 3-13).

# Other Operations

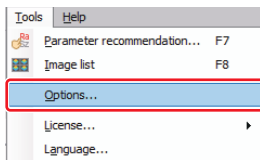
This section describes functions you can perform from the [Tools] menu and [Help] menu on the main menu.

## [Tools] Menu

Multifile Analyzer Software provides tools to change the title display, save settings, and missing data display.

### Setting the Analysis Display

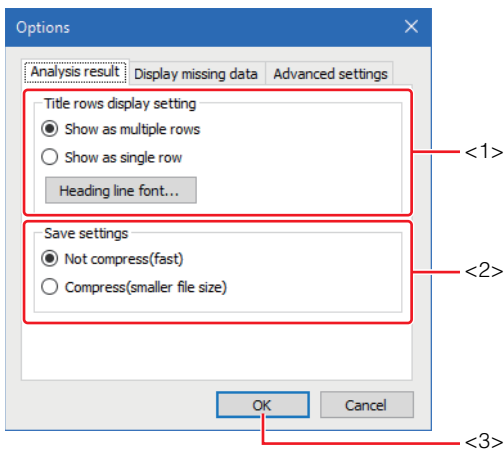
#### 1 Select [Options] from the [Tools] menu.



The [Options] dialog box appears.

#### 2 Select the title rows display setting and the save setting on the [Analysis result] tab.

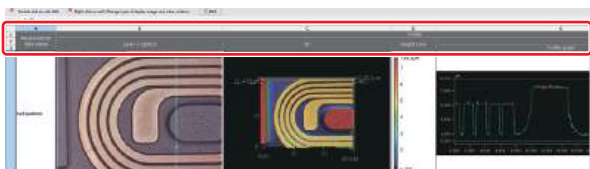
Select how to display the title in the grid display area and whether to enable compression processing when saving analysis results.



##### <1> Title rows display setting

Select whether to display titles with multiple rows or single row in the grid display area.

When the [Show as multiple rows] radio button is selected



When the [Show as single row] radio button is selected



#### <2> Saved settings

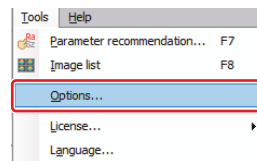
Select whether to perform data compression processing when saving analysis results.

#### 3 Click the [OK] button (<3>).

The [Options] dialog box is closed.

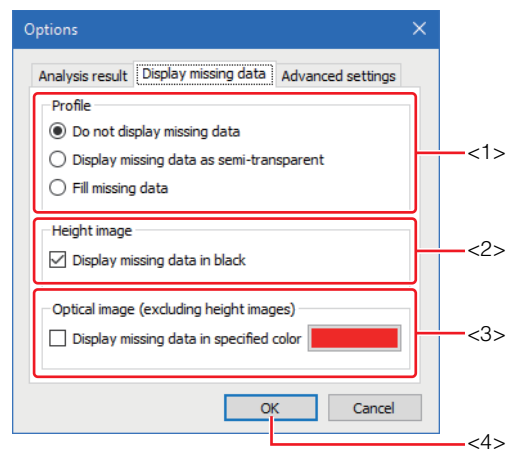
### Setting the Missing Data Display

#### 1 Select [Options] from the [Tools] menu.



The [Options] dialog box appears.

#### 2 Set whether to display missing data on the [Display missing data] tab.



##### <1> Profile

Select whether to display or hide missing points in the profile in the profile display area for each measurement, and dialog boxes for the image processing function.

[Do not display missing data] radio button

Hides segments that use missing points.

[Display missing data as semi-transparent] radio button

Displays segments that use missing points as semi-transparent.

[Fill missing data] radio button

Displays missing points without distinction.

### <2> Height image

Set whether to display missing points of height image in the image display area for each measurement, and dialog boxes for the image processing function.

[Display missing data in black] checkbox

When selected, missing points are displayed in black.

### <3> Optical image

Select whether to display or hide missing points in the texture image in the image display area for each measurement, and dialog boxes for the image processing function.

[Display missing data in specified color] checkbox

When selected, missing points are displayed in the color specified on the color palette. To change the specified color, click the color palette and select from the pull-down list.

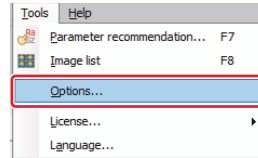
## 3 Click the [OK] button (<4>).

The [Options] dialog box is closed.

From now, missing points will be displayed according to the settings made here.

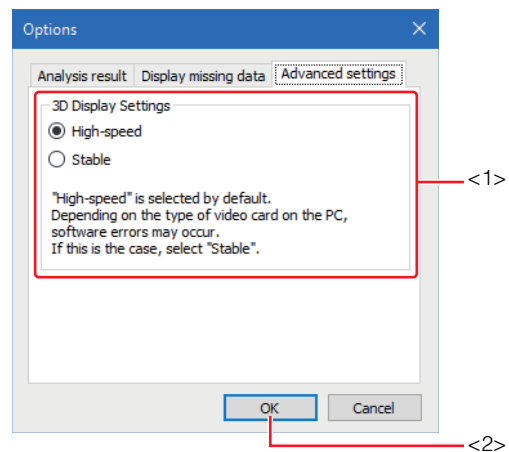
## Setting the advanced display settings

### 1 Select [Options] from the [Tools] menu.



The [Options] dialog box appears.

### 2 Set the advanced display settings on the [Advanced settings] tab.



#### <1> 3D Display Setting

Selects the display speed of the 3D image.

[High-speed] radio button

Displays the 3D image with high speed.

[Stable] radio button

Displays the 3D image in stable state.



If it is set to [High-speed], an error may occur in some environments.

If it is set to [Stable], it is displayed safely without any errors.

### 3 Click the [OK] button (<2>).

The [Options] dialog box is closed.

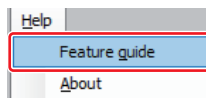
From now, it will display according to the settings made here.

## [Help] Menu

From the [Help] menu, you can invoke the feature guide which describes the functions of Multifile Analyzer Software using flow chart panels, as well the User's Manual which describes how to operate the VK Series. You can also check the version information of the Multifile Analyzer Software currently installed.

## Using the feature guide

### 1 Select [Feature guide] from the [Help] menu.



The [Function guide] panel appears.

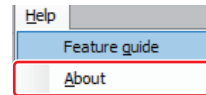
### 2 Click the button of the function you want to learn more about from the operation flow chart.



Explanations for the selected function and operation procedure are displayed.

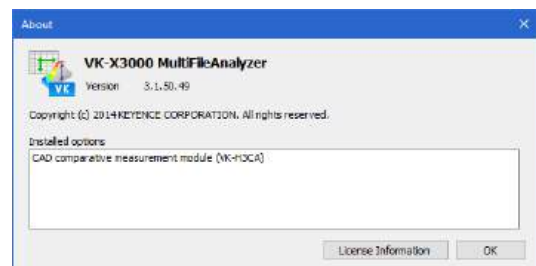
## Checking the version information

### 1 Select [About] from the [Help] menu.



The [About] dialog box appears.

### 2 Check the version information.

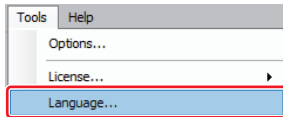


# Switching the Display Language

---

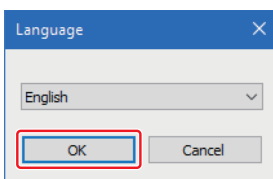
Switch the display language.

## 1 Select [Language] from the [Tools] menu.



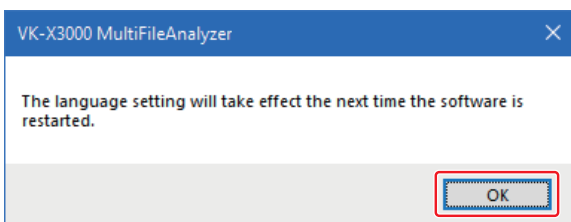
The [Language] dialog box appears.

## 2 Select the display language, and click the [OK] button.



A confirmation message appears.

## 3 Click the [OK] button.




## 4 Restart the software.

# Management Function of the Multifile Analyzer Software

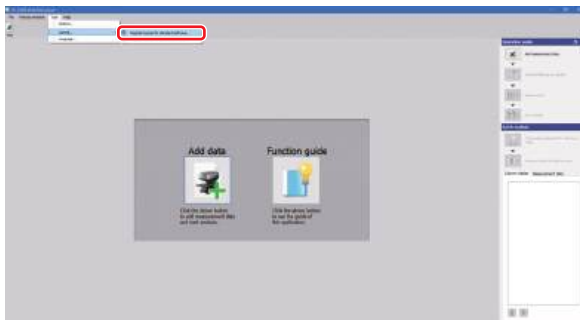
This section gives an overview of Multifile Analyzer Software.

## License

Entering the password is required to enable all of the functions.

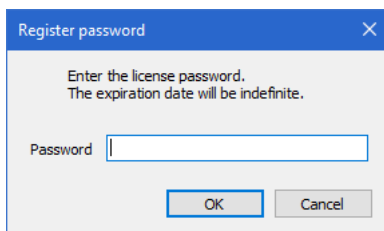
 Refer to the password sheet included with this software to enter the password.

- 1 Click [License] and select [Register license for standard software] from the [Tools] menu.



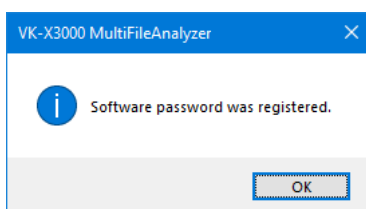
The [Register password] dialog box appears.

- 2 Enter the password and click the [OK] button.



The dialog box appears to confirm that the registration has finished.

- 3 Click the [OK] button.



# Installation/Uninstallation

---

This section describes the operating environment for installing the Multifile Analyzer Software and also describes the procedure for installing and uninstalling the Software.

## Operating Environment

The following conditions are required for the control PC which is used to install the Multifile Analyzer Software.

### Operating environment

OS	Windows 10/11 Pro 64-bit version must be pre-installed.
CPU	Intel® Core™ i5-11600 or later
Memory	16 GB or more
USB port	USB 2.0 x 2, USB 3.0 x 1
Video card	NVIDIA® T400 2GB
Display resolution	1920 x 1080 pixels



- **While the Multifile Analyzer Software is in use (during telecommunication with the control unit), using Windows sleep feature may result in the control unit being in the disconnected state when recovering from sleep mode.**
- **During communication with the control unit, please be sure not to perform the sleep operation or hibernate the PC.**  
**To go into the sleep mode or hibernation mode of the PC, turn OFF the power of control unit.**
- **If the communication with the control unit is lost, turn OFF the power to the unit and turn it ON again.**
- **During communication with the control unit, avoid disconnecting the USB cable.**
- **When using external media like USB device or HDD (Hard Disk Drive) at the same time, connect them to ports attached to a different root hub. If the other USB devices are inserted and removed to and from the same root hub as that of this unit, they all may malfunction.**

## Installing

Place the VK-X3000 Series Software DVD-ROM in the DVD drive of the control PC and install according to the instructions displayed on the screen.

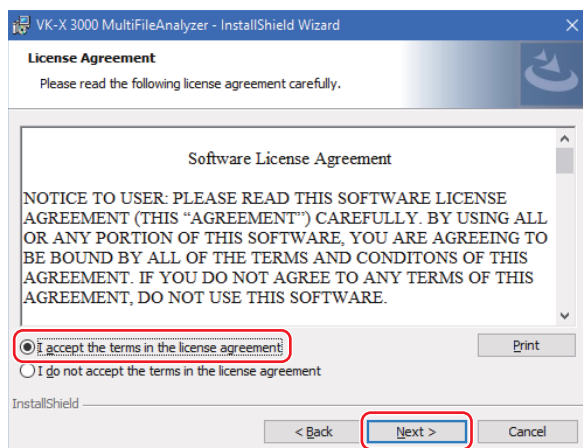
### Point

- The software must be installed on the Administrator user account on the Windows 10 control PC.
- Uninstall the currently installed application software before updating or reinstalling the software.
- When updating or reinstalling the application, if the [User Account Control] dialog box appears, click the [Yes] button.

### 1 Set the VK-X3000 Series Software DVD-ROM to the DVD drive mounted on the control PC.

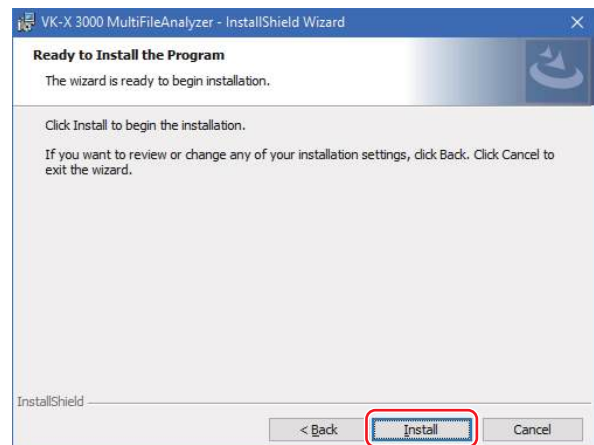
The installation software starts automatically and the window of the installation wizard appears.

### 2 Confirm the description, and then click the [I accept the terms of the license agreement] radio button and the [Next] button.



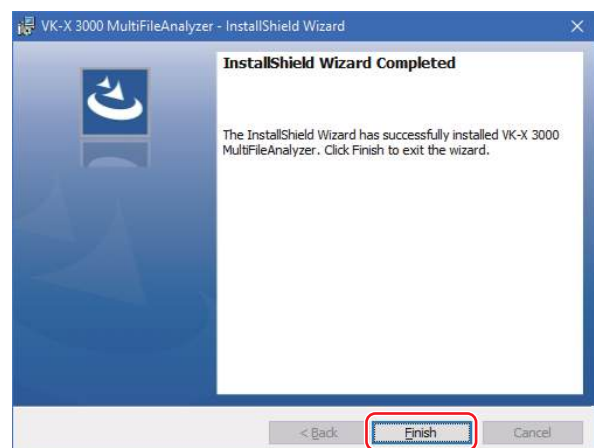
A message indicating that the installation is ready to start appears.

### 3 Click the [Install] button.



Installation starts.

### 4 Click the [Finish] button.



Installation is completed.

## Uninstalling

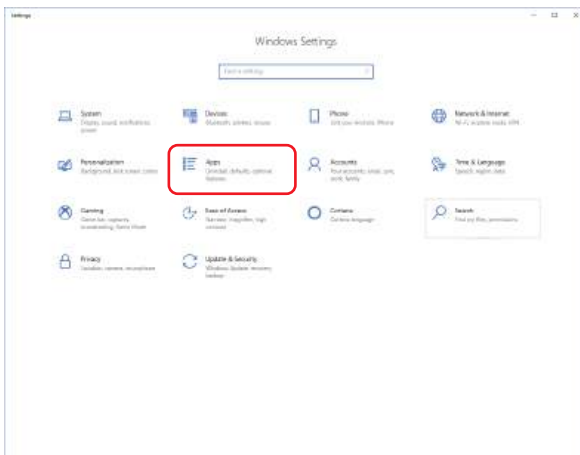
This section describes how to uninstall the VK-X3000 Series Software.

- Point**
- The software must be installed on the Administrator user account on the Windows 10 control PC.
  - When uninstalling the application, if the [User Account Control] dialog box appears, click the [Yes] button.

### 1 Select [Settings] from the [Start] button on the Windows 10 task bar.

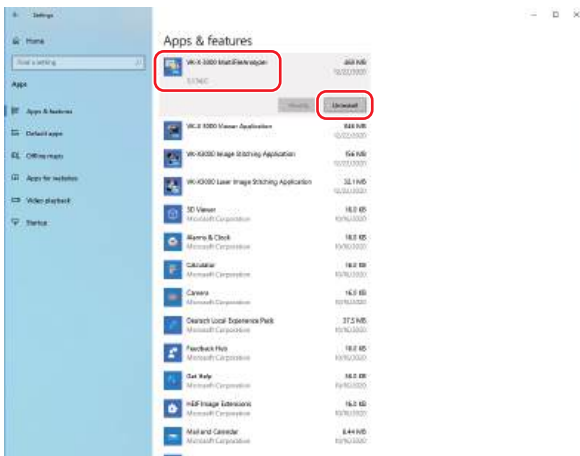
The [Settings] window appears.

### 2 Click [Apps].



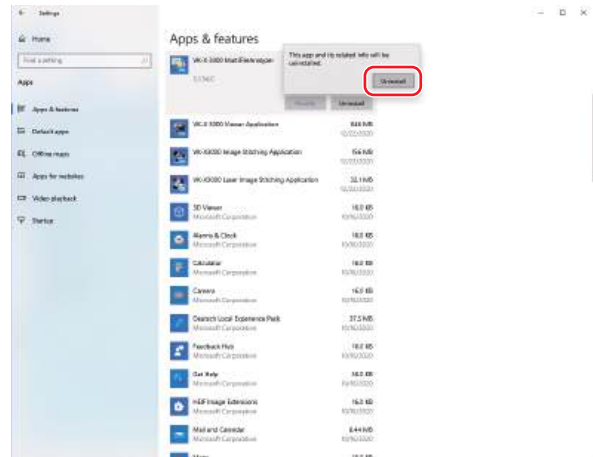
The [Apps & features] window appears.

### 3 Select [VK-X 3000 MultifileAnalyzer] and click the [Uninstall] button.



The confirmation message window appears.

### 4 Click the [Uninstall] button.



The VK-X3000 Series Software is removed.

- Point**
- If the confirmation message of deleting shared files appears, click the [Yes] button to delete them.

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# Revision History

Print date	Revision no.	Description
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March 2021	2nd edition	
June 2021	Revised 1st edition	
October 2022	Revised 2nd edition	
July 2023	Revised 3rd edition	
May 2024	Revised 4th edition	

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